Air Quality Assesment Studies For the City of Sault Ste. Marie (1976-1978)

JULY 1980

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AIR QUALITY ASSESSMENT STUDIES

IN THE CITY OF SAULT STE. MARIE

(1976 - 1978)

TECHNICAL SUPPORT SECTION

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SUDBURY

R. Potvin and W. D. McIlveen

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I SUMMARY

Ambient concentrations of sulphur dioxide (SO_2) gas were monitored successively at a downtown commercial/residential location and at a residential/industrial location in Sault Ste. Marie during the period 1976 to 1978. SO_2 concentrations were generally very low and well within Provincial criteria at both locations, such that SO_2 emissions from Algoma Steel appear to have minimal impact on local air quality. Sulphation rate measurements taken since 1970 also indicated that ambient SO_2 (and/or reduced sulphur compounds) concentrations were generally very low.

Particulate levels determined by dustfall and hi-vol measurements were frequently excessive at distances less than 1.5 kilometres from Algoma Steel, and were observed to decrease sharply with increasing distance from the steel mill. Samples collected in the vicinity of the steel mill generally had elevated levels of iron, coke, "free" carbon, and on occasion elevated levels of sulphate, nitrate, manganese and polynuclear aromatic hydrocarbons (PAH). The major portion (about 66% by weight) of the PAH compounds examined was associated with particulates in the respirable size range.

Dustfall levels in Sault Ste. Marie have not changed appreciably since 1970. At sites in the vicinity of the steel mill, about 62% of the samples collected since 1970 exceeded the Provincial monthly criterion. At sites greater than about 1.5 kilometres from the industrial complex, approximately 6% of the samples were in exceedance of this criterion.

An overall reduction of between 45% to 50% in dustfall levels at sites closest to Algoma Steel would have to be achieved in order to ensure compliance with the Provincial annual criterion.

Suspended particulate levels were significantly higher in the industrial sector near Algoma Steel than in the downtown residential/commercial section. A reduction of about 50% in suspended particulate levels at the Bonney St. location would be required in order to ensure compliance with the Provincial criterion.

Fluoridation rates were generally higher in the vicinity of the steel mill and were occasionally in excess of the Provincial criteria during the growing season. The data indicated that fluoride emissions from Algoma Steel increased mean fluoridation levels by about 15 ug F/100 cm^2/30d above urban background levels.

Vegetation growing in the vicinity of the steel mill contained amounts of iron and fluoride considered to be excessive. Concentrations of iron, fluoride, arsenic, manganese and zinc in the foliage tended to decrease with distance from the mill. There was some indication that arsenic may be accumulating in soil at some sites in close proximity to the mill.

Snow samples collected in the vicinity of Algoma Steel were heavily contaminated with suspended solid material. Samples collected nearest to the mill had substantial amounts of iron, manganese, lead, aluminum, copper, zinc, potassium, calcium, magnesium, sulphate and arsenic.

II AIR QUALITY MONITORING NETWORK:

An air quality monitoring program was originally instituted in the City of Sault Ste. Marie in 1962 with the installation of a high volume air sampler at the Province of Ontario Building located at the corner of MacDougald and Albert Streets. This program was later expanded on a number of occasions such that at the end of 1975, the network comprised 17 dustfall jars, 2 high volume samplers, 1 coefficient of haze (COH) monitor, 10 sulphation candles and 5 fluoridation candles. The evolution of this monitoring program, together with all of the air quality monitoring data collected from 1962 to the end of 1975 were documented in a Ministry of the Environment report (1) released in June 1976.

In 1976, the monitoring program was modified as follows: a continuous sulphur dioxide (SO_2) analyzer (Beckman 906A) was installed in the Ministry of the Environment office adjacent to the Land Registry Office (Station 71049) located at the corner of Elgin and Queen Streets. A COH monitor (relocated from the Province of Ontario Building on Albert Street) was added to the Land Registry Office Station.

An air monitoring station (station 71022) was put into service at the Soo College Building located on Queen Street West near James Street with the following monitors: high volume sampler, dustfall jar (relocated from the Beaver Hotel site across the street), and a sulphation and fluoridation candle. In January 1978, the SO_2 analyzer and COH monitor from the Land Registry Office Station were relocated to the Soo College Station.

Dustfall monitoring was terminated in 1978 at the Alexander Henry High School site (station 71014) and at Our Lady of Lourdes Separate School site (station 71017) because of the low levels of dustfall recorded at these sites since 1970.

Consequently, at the end of 1978, the air pollution monitoring program comprised 15 dustfall jars, 3 high volume samplers, 1 COH monitor, 1 SO_2 analyzer, 10 sulphation candles and 5 fluoridation candles. The approximate locations of the monitoring sites and the monitoring equipment in place at these sites are shown in Figure 1. A list of the site numbers together with the respective station locations and monitor types in place at these sites appears in Table 1. In this table the stations are ordered in increasing distance from Algoma Steel. These distances were measured from the centre of the steel mill complex, however, some sites may actually be closer to a specific contaminant source than indicated due to the large size of this complex.

III SULPHUR DIOXIDE MONITORING PROGRAM:

A) SO_2 Levels at the Land Registry Office Station

Ambient levels of SO_2 gas were monitored at this downtown location from September 1976 to January 1978 with a Beckman 906A analyzer. This instrument is specific to SO_2 and utilizes the coulometric detection principle. The absorbing solution is a neutral buffered iodide electrolyte. Ambient levels of SO_2 are measured continuously in parts per million (ppm) of air sampled (by volume).

The SO_2 data acquisition record and a summary of the hourly data collected are presented in Tables 2, 3 and 4. A total of 8729 hours of valid data were collected, the majority of which were obtained in 1977. The annual average concentration in 1977 was 0.007 ppm. This is the only year for which there was a sufficient data base to report an annual mean at that station, with confidence. These levels are comparable to those recorded by Ministry of the Environment monitoring stations at locations such as North Bay and some of the stations in the Sudbury basin (e.g. Burwash, Callum, Rayside) which are removed (> 15 km) from the Sudbury area smelters (2). The maximum hourly reading recorded at the Land Registry Office Station was 0.15 ppm, and the maximum 24-hour average (midnight to midnight) concentration was 0.04 ppm. These figures are well below the Provincial criteria of 0.25 ppm for a 1-hour average and 0.10 ppm for a 24-hour average. In addition, 8679 hours from a total of 8729 hours of valid data collected (or 99.4%) had SO_2 values in the range 0 to 0.04 ppm.

The monthly average SO_2 levels were grouped as to the heating and non-heating seasons, with the heating season being defined as the period from November to March. For the heating season, the average monthly SO_2 concentration was 0.010 ppm, whereas for the non-heating season (April to October) the average monthly concentration was 0.002 ppm. The few readings that were over 0.04 ppm were all recorded during the heating season. Such a seasonal dependence in the SO_2 levels in an urban location is a strong indication that the higher SO_2 levels during the colder months result primarily from residential and commercial space heating emissions.

Consequently, the SO_2 data collected at the Land Registry Office station indicate that a) the levels of SO_2 in downtown Sault Ste. Marie are low and are well within the Provincial criteria, and b) SO_2 emissions from the Algoma Steel complex appear to have minimal impact on the air quality in the downtown commercial/ residential section of the City.

B) SO_2 Levels at the Soo College Station

In mid-January 1978, SO_2 monitoring at the Land Registry Office station was terminated. At that time a TECO Model 43 SO_2 analyzer was installed at the Soo College Station in order to monitor ambient SO_2 levels in the west-end portion of the city. The station is approximately 1.0 km from the centre of the Algoma Steel complex (see Figure 1). The TECO SO_2 analyzer utilizes ultraviolet pulsed fluorescence (wavelength 190-230 nanometers) as the detection principle.

The SO_2 data acquisition record and a summary of the SO_2 hourly data collected are presented in Tables 2, 3 and 4. In 1978, 7634 hours of valid data were collected. The annual average concentration was 0.008 ppm, which is comparable to the annual average obtained in 1977 (0.007 ppm) at the Land Registry Office. The maximum hourly reading recorded at the Soo College was 0.75 ppm, and the maximum 24-hour average (midnight to midnight) concentration was 0.13 ppm. This value is slightly in excess of the Provincial criterion of 0.10 ppm for a 24-hour period. In addition, the 1-hour Provincial criterion of 0.25 ppm was exceeded on 9 occasions during the year, whereas the 24-hour criterion was marginally exceeded on 3 occasions. These excessive values were all recorded during April 11, 12 and 13. Surface meteorological data from the Sault Ste. Marie airport weather office during the fumigations (see Table 5) indicate that the winds were strong (generally greater than 20 km/hr) and were predominantly from the west. Since the monitoring station is located east of the Algoma Steel complex, the airport meteorological data implicate SO_2 emissions from Algoma Steel as the source of the fumigations.

In general, however, the levels of SO_2 in the area of the Soo College station in 1978 were rather low and well within Provincial criteria. Consequently, SO_2 emissions from the Algoma Steel complex, outside of the isolated fumigations recorded in April 1978, appear to have a minor impact on the air quality in the industrial/residential area of Queen Street in Sault Ste. Marie.

IV PARTICULATE MONITORING PROGRAM:

A) Dustfall Measurements

This sampling method determines the amount of settleable particulate material in the air and provides an indication of the levels of the larger dust particles in an area. The dustfall mass results mostly from particles in the 25 to 100 micron diameter size range, with typical mass median diameters of 50 to 60 microns. The sampling technique is subject to considerable variability largely due to recirculation and loss of material by air currents. The efficiency of the dustfall collector is also dependent on the amount of rainfall during the collection period. Nevertheless, dustfall sampling does provide a measure of the amount of dust in an area and data obtained from such measurements are routinely used to identify dust problem areas. In addition, dustfall samples can also be analyzed for various elements and compounds, including optical microscopic identification of the type of particulates (e.g. coal, coke, graphite, road dust, grain dust, wood chips, etc.), such that a considerable amount of knowledge of the type and amount of dust can be gained with this simple sampling method.

Dustfall collectors are constructed of thick polyethylene and measure about 45 cm. high and 15 cm. in diameter. They are left exposed to the atmosphere for a period of 30 days, and are usually secured to hydro poles with a suitable bracket approximately 3.6 metres above ground. The weight of dustfall material collected during the exposure period is determined and the results are expressed in grams/metre^2/30 days. The Provincial criterion for total dustfall is 7.0 gm/metre^2/30 days. For a 12-month period, the criterion is 4.6 gm/metre^2/30 days.

i) Total Dustfall

The monthly total dustfall levels in 1976, 1977 and 1978 for all the monitoring stations located in the City of Sault Ste. Marie are presented in Tables 6 to 23. The data collected since these stations have been in operation are also presented for comparative purposes. Underlined values exceeded the Provincial criterion of 7.0 gm/m^2/30d. The annual mean dustfall levels for each of the stations are presented graphically in Figures 2 to 19. In these figures, the annual criterion of 4.6 gm/m^2/30d is indicated by the horizontal dotted line.

From these figures, it is observed that the levels of dust have been consistently elevated at the monitoring stations listed below:

STATION	TOTAL NO. OF VALID SAMPLES COLLECTED	NO. OF SAMPLES ABOVE PROVINCIAL CRITERION		OVERALL MEAN* DUSTFALL LEVELS
Korah Rd/Wallace Terr.	42	25	(60)	8.3
Beaver Hotel	77	64	(83)	13.0
Soo College	24	20	(83)	11.0
Sault Locks	42	10	(24)	5.7
People's Rd.	38	8	(21)	7.0
Fairview Avenue	39	24	(62)	8.1
Adelaide Street	37	19	(51)	11.7
Bonney Street	40	38	(95)	15.1
Wilding Ave/Wallace Terr.	35	16	(46)	8.3
Bayview Public School	100	71	(71)	9.5
Total	474	295		

*All values are in gm/m^2/30d.

The data base used in this table comprises all the monthly dustfall values collected since the inception of the stations as presented in the data tables in the appendix. The values in parentheses are the percentage number of samples in excess of the Provincial criterion. It is observed that at the majority of these stations the Provincial criterion was exceeded for more than 50% of the samples. In addition, the overall mean dustfall levels at most of these stations were well above the Provincial annual criterion of 4.6 $gm/m^2/30d$. For this group of stations, a total of 474 monthly samples were obtained up to and including December 1978, of which 295 samples (i.e. 62% of the samples) exceeded 7.0 $gm/m^2/30d$. All of these stations, except those on People's Rd. and Fairview Ave., are located less than about 1.5 kilometres from the centre of the Algoma Steel complex (see Table 1).

The remainder of the dustfall monitoring stations had levels at or below acceptable levels as shown below:

STATION	TOTAL NO. OF VALID SAMPLES COLLECTED	NO. OF SAMPLES ABOVE PROVINCIAL CRITERION		OVERALL MEAN* DUSTFALL LEVELS
Land Registry Office	40	5	(13)	4.1
S.F. Howe Public School	96	8	(8)	4.9
Franklin St. Public School	100	3	(3)	3.9
Prentice Ave/Doncaster St.	88	7	(8)	4.2
Holy Angels Separate Sch.	99	9	(9)	4.6
James Lyons Public School	97	3	(3)	3.3
Alexander Henry High School	89	0	(0)	2.6
Anna McRae Public School	85	4	(5)	2.4
Total	694	39		

* All values are in $gm/m^2/30d$

For this group of stations, the percentage number of samples in excess of the criterion at any location was generally less than 10%, and overall mean dustfall levels were generally less than 4.6 $gm/m^2/30d$. A total of 694 samples were collected at these sites up to and including December 1978, of which only 39 samples (i.e 6%) of the samples exceeded 7.0 $gm/m^2/30d$. These stations are located about 2 kilometres or more from the centre of the Algoma Steel complex.

The overall mean dustfall levels for all stations since these have been in operation are presented graphically in Figure 20 as a function of distance from the centre of the Algoma Steel complex. In this analysis, the only station parameter considered was its distance from Algoma Steel. Figure 20 indicates that the levels of dustfall decrease rapidly with increasing distance from Algoma Steel. At distances less than about 1.5 km, dustfall levels are, on average, in excess of 8.0 $gm/m^2/30d$. The only exception is at the Sault Locks station (71048) with average levels in the range of 5.7 $gm/m^2/30d$. The lower levels at that site may result from i) a greater ventilation rate of the atmosphere due to the presence of the St. Marys River, ii) generally higher deposition velocities of particulates over smooth surfaces (in this case flat terrain surrounded by a body of water, and iii) smaller contributions to the dust loadings from general urban activities owing to its location somewhat removed from the City of Sault Ste. Marie.

At distances greater than about 1.5 km from Algoma Steel dustfall levels are generally at or below acceptable levels. Annual mean dustfall levels ranging from 2 to 4 $gm/m^2/30d$ have commonly been observed at a number of urban monitoring locations in Northeastern Ontario and are believed to be representative of levels in urban areas with non-industrial activities. Monitoring stations 71046 (Fairview Avenue) and 71047(People's Road) as shown in Figure 20, show higher levels than would be expected from the trend established by the other sites. These stations were established to monitor particulate emissions from a wood products operation in the People's Rd./Fairview Avenue area. Microscopic analyses of the particulate material collected at these sites indicated that in fact emissions from the wood products operation and road dust were the main sources of dustfall at these locations.

From Figure 20, it would appear that particulate emissions from the Algoma Steel complex in Sault Ste. Marie are the cause of excessive dustfall levels and that the area of greatest impact extends to about 1.5 km from the centre of the complex. In addition, a reduction of approximately 65% to 70% in total dustfall levels at sites closest to Algoma Steel would have to be achieved in order to ensure compliance with the Provincial ambient annual air quality criterion.

Entrainment of particulates deposited on the ground over a number of years can contribute substantially to the dustfall levels during the summer period as a result of vehicular traffic, wind, etc., to the extent of masking and/or exceeding contributions from current emissions. In an attempt to arrive at an estimate of the relative

contributions of entrainment vs current emissions to the dustfall levels measured in Sault Ste. Marie, the monthly dustfall data for each station were identified as either summer (April to October) or winter (January, February, March, November, December) samples. These periods correspond to no-snow and snow cover perioαs respectively in Northern Ontario. Mean winter and summer dustfall levels were determined for each station for the data base available from each site.

The results of this exercise are summarized in the following table:

Mean Dustfall Levels ($gm/m^2/30d$)

Distance From Algoma Steel	Winter	Summer	Increase ($gm/m^2/30d$)	% Increase
Less than 1.5 km	8.9	10.8	1.9	21
Greater than 1.5 km	2.9	4.5	1.6	55

For stations located less than about 1.5 kilometres from the centre of the Algoma Steel complex, the mean winter dustfall level was 8.9 $gm/m^2/30d$, whereas the mean level for the other more distant stations was 2.9 $gm/m^2/30d$. Thus when entrainment is negligible due to snow cover, stations in the vicinity of the steel mill complex recorded dust levels three times higher than at the more distant stations. The mean dustfall level during the summer period was 10.8 $gm/m^2/30d$ for the close-in stations, and 4.5 $gm/m^2/30d$ for the more distant stations. On average, the actual increase in the mean levels during the summer period was marginally higher at the close-in stations (1.9 vs 1.6 $gm/m^2/30d$). Finally, the percentage increase was substantially higher at the more distant sites (55% vs 21%).

These results indicate that the higher dust levels measured in the vicinity of the Algoma Steel complex are primarily the result of current emissions. On the assumption that the higher summer levels at the close-in stations are caused solely by entrainment, i.e. not taking into account prevailing wind directions, then entrainment of dust having accumulated on the ground in the area of the steel mill complex appears to contribute to about 20% of the measured dustfall levels. Hence, on the basis of this assumption, it would seem that a reduction of approximately 45% to 50% in total dustfall levels (caused by current emissions) at sites closest to Algoma Steel would have to be achieved in order to ensure compliance with the Provincial ambient annual air quality criterion.

The trend in dustfall levels with time for each station can be determined by inspecting Figures 2 to 19. In the group of stations located more than 1.5 km from the centre of the Algoma Steel complex, some of the stations, for example Holy Angels S.School (71016), Franklin St. P. School (71018), and S. F. Howe P. School (71019), have had somewhat higher dust levels since 1974. The remainder of stations in this group (71012, 71013, 71014, and 71017) have had fairly constant levels since 1971. The annual average dustfall levels for this group of stations since 1971 are as follows:

YEAR	AVERAGE DUSTFALL VALUES ($gm/m^2/30d$)
1971	3.5
1972	2.9
1973	2.9
1974	4.3
1975	4.0
1976	4.1
1977	4.1
1978	4.4

The upward trend as of 1974 is mostly a reflection of increased dustfall levels at sites 71016, 71018 and 71019. However, this is not considered to be of significance since the increments have been marginal.

In the group of stations located less than about 1.5 km from Algoma Steel only two sites, namely 71010 (Beaver Hotel) and 71015 (Bayview Public School), have been collecting data since 1971. At site 71015 (see Figure 6), annual average dustfall values have been greater than the criterion since 1971 and have since remained fairly constant. Dust levels at site 71010 (see Figure 2) have also remained fairly constant since 1971. Relocation of the monitoring station across the street to site 71022 has not resulted in appreciable differences in measured dust levels in that area. Dustfall levels at the stations installed in 1975 have remained elevated and fairly constant at the following locations: 71042 (Bonney St.), 71043 (Wilding/Wallace), 71048 (Sault Locks) and 71044 (Korah Rd./Wallace Terr.). At site 71045 (Adelaide St.) the levels were lower in 1978 as shown in Figure 15. The annual average dustfall levels for this group of stations since 1975 are as follows:

YEAR	AVERAGE DUSTFALL VALUES ($gm/m^2/30d$)
1975	10.1
1976	10.3
1977	10.8
1978	9.0

Consequently, for the stations in the proximity of the steel complex, the average dustfall levels have not changed appreciably since 1975.

ii) Elemental Analysis

From 1976 to 1978, the contents of the dustfall jar at station 71049 (Land Registry Office) were analyzed for the following metals: arsenic, copper, iron, lead, nickel and zinc. The results of these analyses are presented in Table 24. It is observed that for the metals listed, iron had the highest values followed by lead and zinc. The levels of copper and nickel were at the detection limit of the analytical methods used, whereas the levels of arsenic were generally below the detection limit. There are no Provincial criteria for metals in dustfall. However a Provincial guideline for lead in dustfall of 0.1 $gm/m^2/30d$ is currently in effect. The lead levels at the Land Registry Office station were well within this guideline. In general, the metal levels shown in Table 24 are similar to those obtained in other urban communities of northern Ontario.

iii) Microscopic Analysis:

The insoluble portions of dustfall for a number of stations were examined with an optical microscope by Ministry personnel at the Air Quality Laboratory, Physical Methods Section. This analysis was done on alternate months such that from February 1976 up to and including December 1978 a total of 167 samples were examined. The major dust constituents identified were the following: graphite, coal and coke, fly

ash, road dust (silica), wood char, iron oxide, biological material and others. The relative amounts of these substances in the dustfall samples were semi-quantitatively determined as an estimated volume percentage occupied by each type of particulate material when uniformly distributed on a microscope slide. These analyses were done on samples from the following stations: 71012 (Anna McRae Public School), 71048 (Sault Locks), 71010 (Beaver Hotel), 71015 (Bayview Public School), 71042 (Bonney St.), 71045 (Adelaide St.), 71043 (Wilding Ave/Wallace Terr.), 71044 (Korah Rd/Wallace Terr.), 71046 (Fairview Ave.) and 71047 (People's Rd.). The results of these analysis are presented in Tables 25 to 46.

At stations 71010, 71015, 71042, 71043, 71044, 71045 and 71048, the major dust constituents identified were coal and coke, with estimated volume percentages ranging from 59% to well over 90%. The 1978 data indicate that coke comprised most of the coal-coke fraction. This type of particulate material is generally associated with the coke production facilities which are an integral part of the steel making operations. Secondary constituents included road dust (silica), biological material and graphite. In addition, minor constituents such as fly ash, iron oxide and wood char were also identified. These stations are located within a radius of about 1.5 km from the centre of the Algoma Steel complex. As discussed in a previous section, dustfall levels at these sites were frequently excessive. The optical microscopic identification of particulates collected at these sites implicates the steel mill as the major source of particulates in dustfall.

At station 71012 (6.4 km SE of the Algoma Steel complex), the coal-coke fraction of dustfall was generally lower, with average levels in the 30% to 40% range (see Tables 26 to 28). Entrainment from road dust and biological material accounted for the largest fraction of dustfall during the time of year without snow cover graphite particulate material was observed in amounts similar to those obtained at sites within 1.5 km from the Algoma Steel complex. Consequently, the impact of particulate emissions from the steel making operation appears to be considerably less at this site in comparison to that observed at the close-in sites. This is substantiated by the low dustfall levels obtained at station 71012.

At sites 71046 and 71047 (located 3.36 and 3.84 km NNE of the Algoma Steel complex), the largest fraction of particulate material consisted of wood char and wood shavings (see Tables 42 and 43). This is not surprising since these sampling sites were set adjacent to a wood products operation, in order to monitor particulate emissions from the plant. Entrainment from road dust and biological material accounted for the second largest fractions of dustfall. The coal-coke fraction was considerably lower, averaging about 10% by volume of dust. Hence the excessive dust levels observed at these sites appear to be caused primarily by particulate emissions from the wood products plant.

In summary, the identification of particulate material through optical microscopy indicates that a major portion of dustfall material collected near the Algoma Steel complex from 1976 to 1978 consisted of carbonaceous matter (primarily coke) normally associated with steel making operations.

iv) Loss on Ignition

Some of the samples collected at sites 71046 and 71047 were analyzed for mass loss on ignition in order to determine the amount of combustible material (e.g. wood shavings, wood char etc.) in dustfall. For this analysis, the insoluble portion of dustfall, i.e. material retained on a Whatman No. 4 filter paper, was heated to 600°C. The percent weight loss was then determined from the weight difference obtained as a result of the loss of combustible material.

During 1976 and 1977, 11 dustfall samples collected at site 71046 were analyzed for loss on ignition. The weight loss varied from 13% to 77% with an overall average of 36%. Nine samples collected at site 71047 were also analyzed for loss on ignition, yielding an average weight loss of 20%. These data confirm the optical microscopy studies in that the amount of combustible material in these samples, namely wood char and wood shavings, was generally elevated.

B) High Volume Sampling

This sampling method determines the mass concentration in micrograms/metre^3 (ug/m) of suspended airborne particulate material by drawing a large air volume (about 2000 m^3) over a preweighed filter medium.

In Ontario, standard operation of the sampler involves air flow rates between 40 and 60 cubic feet per minute (cfm) and the use of Gelman A glass fiber filters. A sample is collected over a 24-hour interval (midnight to midnight) every sixth day.

In addition to the determination of the mass concentration of particulates, some of the filters exposed in Sault Ste. Marie were analyzed for heavy metals, water soluble sulphate ($SO_4^=$) and nitrate (NO_3^-) and total carbon, and polynuclear aromatic hydrocarbons (PAH). In addition, two brief PAH sampling surveys were undertaken in the summer of 1977 and 1978.

i) Total Suspended Particulate (TSP)

A summary of the 1976, 1977 and 1978 total suspended particulate data collected at the Land Registry Office, Soo College and Bonney Street stations is presented in Table 47. The annual mean TSP levels are also presented in histogram form in Figures 21, 22 and 23.

At the Land Registry Office station, TSP levels were generally well below acceptable levels during this three-year period, with annual geometric means (annual criterion: 60 ug/m^3-geometric mean) ranging from 38 to 44 ug/m^3 (see Figure 21). Only 3 samples exceeded the 24-hour Provincial criterion of 120 ug/m^3 from a total of 99 samples collected. Based on TSP data collected at other locations in Northeastern Ontario, these particulate concentrations are typical of an urban location with a wide spectrum of dust sources (e.g. vehicular traffic, construction activity, street cleaning, space heating, etc.).

Total suspended particulate levels at the Soo College station were generally in excess of the annual criterion with annual geometric means ranging from 64 to 72 ug/m^3 (see Figure 22). Of the 120 samples collected during the period 1976 to 1978, 16 samples were in excess of the 24-hour criterion. These dust concentrations are almost double those measured at the Land Registry Office station, and are higher than levels generally obtained for urban residential/commercial locations.

At the Bonney St. station, located in the immediate vicinity of the Algoma Steel complex, TSP levels were significantly in excess of the Provincial criteria during the three-year period as shown in Figure 23. Annual geometric means ranged from 97 to 107 ug/m^3. Concentrations in excess of 400 and 500 ug/m^3 were obtained each year. The 24-hour criterion was exceeded for 65 samples, from a data base of 151 samples.

A statistical analysis of the data was undertaken to determine if the TSP levels had changed during the period 1976 to 1979. The null hypothesis testing method was used to compare annual geometric means for significant differences at the 5% level with the following results:

	SIGNIFICANT DIFFERENCE (5% level)	
STATION	1976-1977	1977-1978
Land Registry Office	No	No
Soo College	No	No
Bonney Street	No	No

The data indicate that there was no significant difference (at the 5% level) at each station in the TSP levels from 1976 to 1978.

The null hypothesis testing method was also used to compare mean TSP levels from the 3 sampling stations in Sault Ste. Marie for significant differences, again at the 5% level. For this test, the data for each station were pooled for the period January 1, 1976 to December 31, 1978. The geometric mean and the geometric standard deviation were determined for each sampling location for that period and summarized in Table 48a. In addition, the data set for each station was inspected for lognormality by obtaining lognormal distribution plots. These plots are presented in Figures 24, 25 and 26 and show that the data are lognormally distributed as indicated by the linear relationship between the logarithms of the TSP values and the cumulative frequency distribution. Hence, this justifies the use of the geometric mean, instead of the arithmetic mean in arriving at a figure for the sample population mean.

The comparison of the geometric mean levels using the null hypothesis gave the following results:

STATIONS COMPARED	SIGNIFICANT DIFFERENCE (5% level)
Land Registry - Soo College	Yes (higher)*
Land Registry - Bonney St.	Yes (higher)
Soo College - Bonney St.	Yes (higher)

*Indicates higher levels at the station underlined.

The data indicate that the mean TSP levels were significantly higher at the Bonney St. station than at the Soo College and Land Registry Office stations. In addition, TSP levels were significantly higher at the Soo College station than at the Land Registry Office station. A plot of the geometric mean TSP levels for the period 1976 to 1978 (Table 48a) with distance of the sampling site from Algoma Steel is shown in Figure 27. It is observed that suspended particulate levels decreased rapidly with increasing distance from Algoma Steel. This trend is similar to the one obtained for total dustfall (see Figure 20). Figure 27 indicates that TSP levels in the City of Sault Ste. Marie are within acceptable limits (annual criterion: 60 ug/m^3-geometric mean) at distances greater than about 1.5 km from the Algoma Steel complex. In addition, a reduction of approximately 50% in suspended particulate levels at the Bonney St. location would be required in order to ensure compliance with the ambient annual air quality criterion.

Finally, the null hypothesis testing method was used to compare mean TSP levels for the summer (April to October) and winter (November to March) periods for each of the 3 stations in order to determine any significant differences at the 1% level) with time of year, ie. for the no-snow and snow cover periods. For this test, the geometric mean TSP levels and the geometric standard deviations were determined for both the summer and winter periods for each station since the start-up of the stations, ie. from July 1975 for the Bonney Street and Land Registry Office stations, and from September 1976 for the Soo College station, up to and including December 1978. The results of this analysis are presented in Table 48b.

The data indicate that the mean TSP levels were significantly higher during the summer period at both the Bonney Street and Land Registry Office stations, whereas at the Soo College station the levels were indentical for both periods.

At the Bonney Street site, the mean TSP levels were 115 and 77 ug/m^3 for the summer and winter periods respectively, such that the summer values were generally 49% higher than the winter values. For both periods, the mean levels were in excess of the Provincial annual criterion of 60 ug/m^3 (geometric mean). This significant seasonal difference in the suspended particulate concentrations can be explained as follows: firstly, the prevailing northerly and northwesterly winds during the winter period position the Bonney Street sampler upwind of Algoma Steel (see Figure 1), with no significant sources of suspended particulate to the north and northwest of the sampler location.

Further, southerly winds during the summer period position the Bonney St. sampler downwind of the steel complex. This, coupled with generally poorer dispersion conditions during the summer period and the proximity of the sampler to the steel complex can explain the higher TSP levels during the summer period at Bonney St. Secondly, entrainment in the summer periods of dust deposited on the ground over a number of years also explain the data presented in Table 48b. However, the elevated dust concentrations measured in the summer periods were usually associated with elevated concentrations of polynuclear aromatic hydrocarbon (PAH) compounds and free carbon implicating current emissions from Algoma Steel as the source. Hence, although entrainment does undoubtedly contribute to some degree to the higher summer values measured at Bonney Street, it is felt that the main reason for such a seasonal difference comes from the differences in prevailing wind direction and dispersion characteristics as discussed above. A micrometeorological program would be required, in conjunction with the hi-vol sampling program, to quantify any contributions from current emissions to the suspended particulate levels measured at Bonney Street.

The seasonal difference in the levels at the Land Registry Office can also be largely explained in terms of seasonal differences in the prevailing wind directions. In the winter period, winds are generally from the north and the northwest such that emissions from the steel complex would not impact at the sampler location. The geometric mean value of 32 ug/m^3 for the winter period at this site is typical of suspended dust levels in downtown locations removed from significant

industrial dust sources. For example a geometric mean of 31 ug/m^3 was obtained at a downstream sampling location in the city of North Bay for the winter periods from 1975 to 1978. The higher dust concentrations at the Land Registry Office during the summer period can be explained in terms of the high occurrence of northwesterly winds in the spring and summer months due to the lake breeze effect from Lake Superior. These winds position the station downwind of the steel complex. This is supported by the slightly higher levels measured at the Soo College station during the summer period. The Soo College with northwesterly winds is located between the steel complex and the Land Registry office (see Figure 1). Entrainment during the summer period is not considered significant since this process apparently does not contribute to the levels measured at the Soo College station. Again, a micrometeorological study would be required to quantify any contributions from entrainment at this location.

Lastly, the lack of a seasonal difference at the Soo College station can be explained in terms of prevailing wind directions during the summer and winter periods. During the winter period northerly and northwesterly winds carry emissions from the steel complex to the sampling station. Due to the high frequency of occurrence of northwesterly winds during the spring and summer months, emissions from Algoma Steel are also directed over the station during the summer period, such that there is no statistical difference in the levels at any time of the year. Entrainment during the summer period apparently does not contribute to the measured suspended particulate concentrations as indicated earlier.

ii) Elemental Analysis:

The high volume filters from the 3 sampling locations were analyzed on a routine basis for copper (Cu), iron (Fe), lead (Pb), manganese (Mn) and nickel (Ni). The results of the elemental analysis performed on these filters are presented in Table 49 and 50. Most of the data were found to follow a lognormal distribution, similar to that for TSP data. Some examples are shown in Figures 28, 29 and 30 for Cu, Fe and Mn data. A statistical analysis, similar to the one performed for TSP data, was undertaken for the period 1976 to 1978 in order to determine any significant differences in the mean levels obtained. The results of this analysis are presented in Table 51.

a) Copper

The levels of Cu in suspended particulate material were generally low and well within the 24-hour Provincial criterion of 50 ug/m^3. The highest levels were obtained at the Land Registry Office station with a geometric mean of 0.43 ug/m^3. These levels are comparable to those obtained in downtown Sudbury during 1976 and 1977 (2). At the other sites, the mean concentrations were lower, with values of 0.30 ug/m^3 (Bonney St.) and 0.27 ug/m^3 (Soo College). The Cu levels at the Land Registry Office station were found to be significantly higher (5% level) than at both the Soo College and Bonney St. stations. However, there was no significant difference in the levels at these latter sites. This anomaly can be explained as follows: Firstly, the particulate Cu emissions from Algoma Steel appear to be very low. Secondly,

anomalously high Cu values have been reported (3) to result from the removal of Cu from the commutator of the hi-vol motor into the air stream due to arcing of the brushes and re-circulation through the filter. These findings are in agreement with studies (4) performed on the exhaust air of hi-vol motors, which indicated that the concentrations of Cu in the exhaust may be considerable. However the extent of contamination (in units of ug/m) has yet to be quantified. Consequently, in areas where the ambient Cu concentrations are very low, contamination from the hi-vol motors may seriously bias the values and caution should be exercised in interpreting the data.

b) Iron

The levels of Fe were generally much higher than those of Cu, with values as high as 99.3 ug/m^3 (Bonney St.). On average, Fe accounted for about 8.1% of the total particulate mass, with values ranging from less than 1% to as high as 17.6%. The Provincial 24-hour criterion for Fe (as Fe_2O_3) in suspended particulates is 25 ug/m^3. This criterion was exceeded on 20 occasions at Bonney St., on 2 occasions at the Land Registry Office and on 6 occasions at the Soo College stations during the period 1976 to 1978. For that period, geometric mean levels were 7.3 ug/m^3 (Bonney St.), 4.2 ug/m^3 (Soo College) and 1.8 ug/m^3 (Land Registry Office); these means were significantly different at the 5% level (see Table 51). Thus, as indicated in Figure 31, the levels of Fe in suspended particulate were observed to decrease rapidly with increasing distance from the steel mill.

Iron levels at the Land Registry Office were similar to those measured in downtown Sudbury. The levels at the Bonney St. and Soo College stations were significantly greater than at monitoring sites near smelter operations in the Sudbury area.

Consequently, the impact of particulate emissions from Algoma Steel on the ambient Fe levels in Sault Ste. Marie is considerable in the vicinity of the steel mill.

c) Lead

Concentrations of Pb at the 3 sampling locations were generally low and well below the Provincial 24-hour criterion of 5.0 ug/m^3. The measured values were typical of those found in downtown locations, where emissions from automobile traffic are the major source of Pb. Statistically there was no significant difference (5% level) in the levels at the 3 sampling locations.

d) Manganese

Mn is of some interest since it is a natural constituent (approximately 2% by weight) of the iron ore mined by the Algoma Ore Division in Wawa which supplies some of the iron sinter to the steel mill in Sault Ste. Marie. Mn concentrations in TSP were generally less than or equal to about 1% by weight, and well below the Provincial 24-hour criterion of 50 ug/m^3. The Mn values bore some correlation with the Fe values, as shown in Figure 32, with a correlation coefficient $R = 0.80$. This

suggests a common source for Mn and Fe. Mn concentrations, on average, were highest at the Bonney St. site with a geometric mean of 0.82 ug/m^3. Mn levels at the Soo College were lower with a geometric mean of 0.28 ug/m^3, whereas Mn levels at the Land Registry Office station approached background values with a geometric mean of 0.06 ug/m^3. These mean values were significantly different from each other at the 5% level as shown in Table 51. Figure 33 shows the concentration gradient of Mn with distance from the steel mill, indicating a pattern similar to that of Fe (see Figure 31). Hence the steel mill is a source of Mn in suspended particulate matter, but at acceptable concentrations.

e) Nickel

A major portion of the hi-vol filters were also analyzed for Ni. As Tables 49 and 50 indicate, the Ni concentrations in TSP were very low with geometric means ranging from 0.003 to 0.010 ug/m^3. The detection limit for Ni in suspended particulate is 0.001 ug/m^3, such that the levels measured in Sault Ste. Marie were in general at or slightly above this limit. For comparative purposes, Ni levels in the Sudbury area near smelter operations had geometric means ranging from 0.08 to 0.18 ug/m^3 during 1976 and 1977 (2).

There was no significant difference (5% level) in the mean levels at the 3 sampling locations, such that contributions from the steel mill to ambient Ni concentrations above background were very small.

iii) Sulphate and Nitrate Analysis

Approximately half of the filters exposed in 1976, and all filters exposed in 1977 and 1978 at the Bonney St. site were analyzed for sulphate ($SO_4^=$) and nitrate (NO_3^-). The soluble $SO_4^=$ and NO_3^- were extracted from the filters with distilled water. The extracts were then analyzed for $SO_4^=$ and NO_3^- using Technicon autoanalyzer methods.

The use of glass fiber filters for determining ambient concentrations of particulate $SO_4^=$ and NO_4^- recently has been the subject of intensive investigations. Laboratory and field studies (5,6, 7,8) have indicated artifact formation of both $SO_4^=$ and NO_3^- particulate material on glass fiber filters due to the sorption of ambient SO_2, NO_2 and HNO_3 by the basic (pH approximately 7.5-9.5) filter component. Ambient concentrations of these potentially interferent compounds were not measured at that site when the hi-vol filters were exposed. However, ambient air quality surveys (9,10) in the vicinity of Algoma Steel by Ministry of the Environment Air Resources Branch personnel with mobile monitoring equipment have shown low levels of both SO_2 and NO_2. Nevertheless, the $SO_3^=$ and NO_3^- data presented here should be considered more in a qualitative than a quantitative fashion, in light of possible interferences.

a) Sulphates

A summary of the data collected at Bonney St. is presented in Table 52. A total of 107 samples were collected with annual geometric means

ranging from 9.4 to 12.6 ug/m^3. The lowest levels recorded ranged from 1.6 to 2.6 ug/m^3, suggesting possible interference effects of at least that magnitude. On occasion, very high values, ranging from 28.4 to 94.9 ug/m^3, were obtained. The $SO_4^=$ levels were generally higher than the NO_3^- levels by a factor of about 9 to 1.

The $SO_4^=$ data for the 3 year period (107 samples) were found to follow closely a lognormal distribution as shown in Figure 34. The geometric mean of the data summarized in this Figure was 10.9 ug/m^3, with a geometric standard deviation of 2.2 ug/m^3.

Since long range transport of sulphates (11,12,13) can contribute substantially to local concentrations, an attempt was made to separate these in order to obtain an approximate figure for particulate $SO_4^=$ contributions from the steel mill complex.

In the first instance, the data were segregated as to the time of year with the following periods: warm season (April to September), cold season (October to March). In the first data set (warm season), 55 samples were collected with a geometric mean of 9.1 ug/m^3, whereas in the second data set (cold season), 52 samples were collected with a geometric mean of 13.3 ug/m^3. The null hypothesis test indicated a significant difference in the means at the 1% level. Since contributions from long range transport are thought to be more significant in the warm season due to prevailing southerly winds in Sault Ste. Marie, it appears that on average, local contributions to $SO_4^=$ levels in Sault Ste. Marie were at least in the order of 4 ug/m^3. This is considered as a very conservative estimate.

Secondly, a positive correlation with Fe was obtained (see Figure 35) with a correlation coefficient R = 0.76, suggesting a common source for both $SO_4^=$ and Fe. A somewhat better correlation was obtained (see Figure 36) for data collected during the cold season (October to March) with a correlation coefficient R = 0.80, again indicating $SO_4^=$ contributions from Algoma Steel.

Finally, analysis of some $SO_4^=$ episodes at the Bonney St. site indicated that, at times, particulate emissions from the steel mill contained elevated amounts of $SO_4^=$, together with elevated TSP, Fe, NO_3, total and free carbon as shown below:

MASS CONCENTRATION (ug/m^3)

DATE (1977)	TSP	FE	$SO_4^=$	NO_3^-	Total Carbon	Free Carbon
November 3	563	99.3	94.9	12.3	86.9	48.5
9	278	23.5	47.4	7.8	97.1	44.2
15	294	21.2	48.9	17.7	48.0	23.4

However $SO_4^=$ data from upwind and downwind (in relation to the steel mill) hi-vol samplers operating simultaneously would be required in order to determine more precisely local vs long range transport contributions. These data will be available in the future since the filters exposed at the Soo College and Land Registry Office site are now being analyzed routinely for $SO_4^=$ as of 1979.

b) Nitrates

The nitrate data for samples collected at Bonney St. are also summarized in Table 52. A total of 110 samples were collected with annual geometric means ranging from 1.1 to 1.5 ug/m^3. The lowest levels obtained (0.1 to 0.3 ug/m^3) were about one order of magnitude lower than the lowest $SO_4^=$ levels (perhaps suggesting less interference effects than for sulphates). Fairly high values were obtained on occasion with maximum values of 15.1 and 17.7 ug/m^3 in 1976 and 1977 respectively. As indicated earlier, the NO_3^- mean levels were considerably lower than the $SO_4^=$ mean levels by a factor of about 1 to 9.

The NO_3^- data for the 3-year period (110 samples) were also found to follow closely a lognormal distribution as shown in Figure 37. The geometric mean of the data summarized in this Figure was 1.2 ug/m^3 with a geometric standard deviation of 3.4 ug/m^3. Hence there was considerable variability in the values.

Nitrates are also known to be an important constituent of acid rain and hence are also subject to long range transport. Consequently, an attempt was again made to separate local and long range transport contributions in order to obtain an approximate figure for particulate NO_3^- contributions from the steel mill complex.

Firstly, the data were segragated as to the warm (April to September) and cold (October to March) seasons. For the warm season, 55 samples

were collected with a geometric mean of 0.85 ug/m^3, whereas for the cold season 56 samples were collected with a geometric mean of 1.86 ug/m^3. Again, the null hypothesis testing method revealed a significant difference in the means at the 1% level. As in the case of sulphates, long range transport is expected to be predominant during the warm season, such that on average, local contributions to NO_3^- levels in Sault Ste. Marie appear to be at least in the order of 1 ug/m^3. This, again is considered to be a very conservative estimate.

Secondly, a positive correlation with $SO_4^=$ was obtained (see Figure 38) with a correlation coefficient R = 0.77. This is not unexpected since both species are constituents of acid rain (long range transport). Further, as shown earlier some of the highest NO_3^- values (> 10 ug/m) were obtained in samples with elevated $SO_4^=$ values in episodes related to steel mill emissions.

Again, however, it must be emphasized that NO_3^- data from an upwind and downwind location in relation to the steel mill would be required in order to determine more precisely local vs long range transport contributions. As is the case for $SO_4^=$, the filters from the Soo College and Land Registry Office site are being analyzed routinely for NO_3^- as of 1979.

In conclusion, elevated $SO_4^=$ and NO_3^- particulate levels were observed on occasion at the Bonney St. sampling site. Some of these elevated readings were ascertained to have occurred with elevated particulate emissions from the steel mill. However more data are required in order to quantify more precisely the local and long range transport contributions.

iv) Free and Total Carbon Analysis

During 1977, some of the filters exposed at the 3 sampling sites were analyzed for "free" and total carbon material. The "free" carbon fraction includes graphite, coal, coke, carbon black, soot, etc., whereas total carbon includes the carbon content of organic fibres, carbonates, biological materials, etc., in addition to free carbon. The analytical method used for these analyses was developed by Ministry of the Environment Laboratory staff. In brief, the method consists of burning the carbonaceous material (after an extraction of the "free" carbon fraction) in an induction furnace in a stream of oxygen. The resulting carbon dioxide is measured by a thermal conductivity detector, and is a measure of the carbon content of the particulate sample.

A summary of the data obtained in 1977 is shown in Table 53. Although the data base is limited, it is apparent that on occasion, the "free" carbon portion of TSP was elevated, especially at the Bonney St. site. The "free" carbon fraction of suspended particulate was, on average, higher at the Bonney St. site with a geometric mean of 9.5 ug/m^3. Mean levels at the Soo College and Land Registry Office sites were 5.6 and 4.1 ug/m^3. The data base was too limited to perform a statistical analysis of the data. However, it appears that the "free" carbon content of TSP decreased with increasing distance from Algoma Steel as shown in Figure 39.

Regression analyses of the "free" carbon and Fe data indicated a rather poor correlation ($R^2 \cong 0.36$), although some of the highest "free" carbon values coincided with some of the highest Fe values. This suggests that the "free" carbon may have been emitted from the coke oven batteries, whereas the Fe material may have been emitted from another source in the mill.

Since there is no Provincial criterion for "free" or total carbon in TSP, the data serves to determine trends with time and location. Hence the main conclusions to be drawn from the available data base are that the "free" carbon levels in TSP at a site adjacent to Algoma Steel (Bonney St.) are higher than at a downtown location (Land Registry Office) by a factor of about 2 (9.5/4.1), and that a reduction of 50% to 60% in the levels at the Bonney St. site would be required in order to attain levels similar to those in downtown Sault Ste. Marie.

v) Polynuclear Aromatic Hydrocarbons (PAH)

Polynuclear aromatic hydrocarbon (PAH) compounds consist of carbon and hydrogen atoms organized in characteristic molecular structures comprising fused benzene rings. Formation of these compounds occurs during incomplete combustion of almost any kind of organic matter. Anthropogenic sources of PAH are mainly the result of intentional burning of solid or liquid fossil fuels for industrial, heating, cooking or transportation purposes. Among industrial sources, the production of metallurgical coke is the single most significant potential source of ambient PAH pollution in Ontario (14, 15). Coke production is estimated to represent approximately 52% (based on B(a)P emission estimates) of PAH emissions from all sources in this Province(15).

Since coke production in Sault Ste. Marie is an integral part of the steelmaking operations, PAH analyses of exposed filters at the 3 hi-vol monitoring sites were performed on a regular basis from 1976 to 1978. PAH data collected prior to 1976 indicated, on occasion, elevated concentrations of PAH compounds (B(a)P and B(k)F) at the Bonney St. site. These data were presented in an earlier Ministry report (1).

In addition to the regular (6-day) hi-vol survey, two special summer surveys were performed in 1977 and 1978 using "mobile" hi-vol units and particle-sizing equipment in order to obtain further information on total suspended particulates and PAH compounds in Sault Ste. Marie.

a) Regular Survey

The PAH data collected during the regular monitoring program are summarized in Table 54. The data cover the period 1975-1978 and are for benzo-a-pyrene (B(a)P) and benzo-k-fluoranthene (B(k)F), the two most common PAH compounds monitored in this Province. B(a)P is considered to be one of the most potent carcinogens of the PAH class of compounds, based on animal experiments (15). Up to a few years ago, lack of suitable analytical techniques restricted ambient measurements to a few selected PAH compounds including B(a)P and B(k)F, and ambient concentrations of these compounds became generally accepted as indicative of environmental contamination by PAH.

The data in Table 54 indicate that during the period 1975-1978, B(a)P and B(k)F concentrations in TSP were considerably lower at the Land Registry Office site than at the Bonney St. and Soo College sites. The data were found to be lognormally distributed hence justifying the use of the geometric mean. Typical examples are shown in Figures 40 and 41. The means from the 3 stations were compared for statistical significance using the null hypothesis at the 5% level, with the following results:

	SIGNIFICANT DIFFERENCE (5% level)	
Stations Compared	B(a)P	B(k)F
Land Registry - Bonney St.	Yes (higher)*	Yes (higher)
Land Registry - Soo College	Yes (higher)	Yes (higher)
Bonney St. - Soo College	No	No

* () indicates significantly higher levels at the station underlined.

The data indicate that B(a)P and B(k)F levels at the Land Registry Office station were significantly lower than at both the Bonney St. and Soo College stations. The data also indicate that there was no significant difference in the average B(a)P and B(k)F levels at the Bonney St. and Soo College stations. Consequently it would seem that, on average, B(a)P and B(k)F levels from 1975 to 1978 were approximately 4 to 5 times higher at the Bonney St. and Soo College sites than at the Land Registry Office site. Figures 42 and 43 show the trend in the levels with distance from Algoma Steel.

Since emissions from residential and commercial furnaces used for space heating purposes are a potential source a B(a)P, an investigation of seasonal variations in B(a)P levels in Sault Ste. Marie was undertaken. The heating season was taken as the period November to March, whereas the non-heating season was defined as the period April to October. The results are summarized in Table 55. Although the B(a)P levels were slightly higher during the heating season, statistically there was no significant difference at the 1% level between the heating and non-heating seasons. This is felt to be largely due to the use of clean fuels (oil, gas, electricity) for space heating purposes and the overriding effect of PAH emissions from the steel complex.

Some of the samples collected in 1977 and 1978 were also analyzed for the following PAH compounds: fluoranthene, perylene and benzo (ghi)perylene. According to Public Health Service surveys (16,17, 18), these compounds are not carcinogenic. These additional data however,

serve to enhance the information base of PAH compounds in Sault Ste. Marie. The results of these analyses are presented in Table 56, together with B(a)P and B(k)F data from the same samples for comparative purposes. From these data, it is apparent that the levels of fluoranthene, perylene and benzo(ghi)perylene were, on average, higher than those of B(a)P and B(k)F by a factor of about 2 to 3. On occasion, elevated levels of perylene (106 ug/1000 m^3) and benzo(ghi)perylene (90 ug/1000 m^3) were obtained at the Bonney St. site. As was the case for B(a)P and B(k)F, the levels of these compounds were observed to decrease with increasing distance from Algoma Steel, such that levels at the Bonney St. site were from 4 to 7 times higher than at the Land Registry Office site. In addition, the levels of these compounds were correlated to those of B(a)P and B(k)F, implying a common source for these polynuclear aromatic hydrocarbons, namely the steel complex.

b) Special Surveys

In August 1977 and June 1978, preliminary investigations of the size distribution of suspended particulates and PAH compounds were undertaken. The particle size data were obtained with standard hi-vol units equipped with 4-stage Andersen 2000 particle sizing samplers. Samples were obtained at various locations in Sault Ste. Marie and at the 3 regular hi-vol monitoring sites. All exposed filters were analyzed for total suspended particulates and for B(a)P, B(k)F, fluoranthene, perylene and benzo(ghi)perylene.

The data obtained from these surveys are presented in Tables 57 to 61. Tables 57 and 58 show the measured concentrations as a function of particle size for TSP (ug/m^3) and PAH (ug/1000 m^3) for 1977 and 1978 respectively, whereas Tables 59 and 60 show the percentage weight distributions for TSP and PAH according to particle size.

In general, the total dust loadings were highest on stage I and on the back-up filter, corresponding to particle diameters $\geq$ 7 microns(um) and $\leq$ 1 um respectively. This is in agreement with current research indicating that the typical aerosol mass concentration is bimodal with peaks near 0.5 um and 8 to 10 um. Particle size distribution plots were obtained for each sample (see Figures 44 and 45 as examples) from which the mass median diameters were determined. The mass median diameters were found to range from 3.5 um to 10 um, with an average value of 5.0 um for all the samples collected. Using a "cut-off" particle diameter of 3.3 um to separate respirable from non-respirable particulates, the ratio of the respirable to the total particulate loading was determined for all Andersen samples collected in 1977 and 1978. The ratios varied from 0.32 to 0.48 with an overall mean of 0.41. Hence, for the samples collected in Sault Ste. Marie during these short summer surveys, approximately 41% of the dust (by weight) was in the respirable size range (< 3.3 um).

The size distributions for the respirable fraction (< 3.3 um) of PAH compounds are summarized in the following table:

PAH Compound	RATIO (RESPIRABLE FRACTION/TOTAL LOADING) Range	Mean
B(a)P	0.44 - 0.87	0.66
B(k)F	0.33 - 0.88	0.66
Fluoranthene	0.45 - 0.86	0.60
Perylene	0.36 - 0.89	0.67
B(ghi)P	0.42 - 0.90	0.70

The data indicate that on occasion from 80% to 90% of the weight of these PAH compounds was associated with aerosol particles less than 3.3 um in diameter. The mean percentage for each PAH compound in this size range varied from 60% to 70%. Hence, approximately two thirds by weight of these compounds was associated with aerosol particles in the respirable fraction of airborne particulate matter. These results are in rather close agreement with those obtained in a study (19) performed in Pittsburgh, in which it was found that more than 75% of the weight of selected PAH compounds was associated with aerosol particles less than 5.0 um in diameter.

c) Regulatory Standards and Guidelines for PAH

At the present time, the Soviet Union is the only country where a maximum allowable concentration has been established for an individual PAH in ambient air. The current Soviet standard for B(a)P, based on extrapolation of maximum no-carcinogenic effect level observed in experiments with rodents, is set at 1 ug/1000 m^3. No information is available regarding the enforcement record of this standard.

The widespread development of regulatory standards and guidelines for individual PAH compounds has not materialized mainly as a result of the lack of definite and specific correlations between quantitative chemical composition and biological activity of complex PAH - containing mixtures as actually found in the environment.

Although at the present time Ontario has no standards or guidelines for PAH in ambient air, the data collected in Sault Ste. Marie serve to establish a data base from which trends in PAH levels will be observed as abatement programs at Algoma Steel are developed. The Ministry of the Environment will continue to monitor PAH levels in Sault Ste. Marie on a regular basis.

In summary, PAH levels (in terms of B(a)P) in downtown Sault St. Marie during 1975 to 1978 were 4 to 5 times lower than at locations near Algoma Steel. On occasion, elevated levels of all selected PAH compounds were observed at locations near the steel mill. In addition, all PAH compounds studied tended to be associated mostly with the fine or respirable fraction of airborne particulate matter.

C) Soiling Index Measurements

Soiling index measurements (Coefficient of Haze - COH) are also used to determine the amount of suspended particulates in the air. The method is based on the change in light transmittance through a paper tape before and after the sampling period. The optical density difference is converted into COH units per 1000 linear feet of air passing through the

filter tape. Although COH measurements do not yield particulate mass concentrations, reasonable correlations with hi-vol data have been observed (20). The main advantage of the COH sampler over the hi-vol air sampler resides in the possibility of telemetering the signal from the COH unit to a data acquisition centre for immediate incorporation into an air pollution index reporting system. In Ontario, most soiling index monitors are used at air pollution index stations and the data are telemetered to a central computer in Toronto. For the Sault Ste. Marie survey, the exposed COH tapes are sent to the Ministry's Air Quality and Meteorology Section, Air Resources Branch Toronto, for analysis on a monthly basis.

The Provincial criterion for soiling is 1.0 COH unit (average) for a 24-hour period and 0.5 COH unit (average) for a 1 year period.

i) <u>Soiling Index Levels at the Land Registry Office Station</u>

A COH monitor was in operation at that site from April 1976 to December 1977. Particulate samples were taken every 2 hours. A summary of the data is presented in Table 62. The highest values recorded were 1.4 and 1.9 COH units/1000 ft of air in 1976 and 1977 respectively. The maximum 24-hour average value recorded was 0.5 in both years, which is within the Provincial criterion of 1.0. Although only 7 months of data were available in 1976, the average COH level of 0.19 was well below the Provincial annual criterion of 0.5 COH unit/1000 ft of air. In 1977, 12 months of data were available and an annual average of 0.21 was obtained, again well within acceptable levels. These COH levels are comparable to those measured in a downtown location of Sudbury during the same time period and are considered to be low.

The monthly average COH levels (see Table 63) were rather constant and hence did not reveal a seasonal dependence. The low particulate levels as evidenced by the soiling readings are consistent with observations made earlier from the hi-vol sampling program.

ii) Soiling Index Levels at the Soo College Station

The COH monitor at the Land Registry Office was relocated to the Soo College in January 1978. A summary of the data collected in 1978 is presented in Table 62. The highest 2-hour value measured was 2.5 COH units/1000 ft of air. The maximum 24-hour average value measured was 1.1, barely in exceedance of the Provincial criterion of 1.0 COH unit/1000 ft of air. Consequently, although the COH levels appear to be higher at the Soo College than at the Land Registry Office station, the levels in 1978 were within acceptable limits.

The monthly average soiling levels are listed in Table 63. Based on only one year of data, it appears that COH levels are higher during the colder months. This phenomenon has been observed in other urban centres of the Province and is believed to result from particulate emissions from residential and commercial heating sources. Contributions to soiling levels from these sources may increase in the coming years as more people turn to wood as a space heating fuel.

Consequently, the soiling index levels at the Land Registry Office and Soo College sites were within acceptable limits during the period 1976 to 1978.

V SULPHATION RATE MONITORING PROGRAM:

Sulphation rate is measured by exposing small plastic plates or tubes (candles) coated with lead peroxide (PbO_2) to the atmosphere for 30-day periods. The PbO_2 reacts with gaseous sulphur dioxide to form lead sulphate. The quantity of sulphate formed is analytically determined and reported as milligrams of sulphur trioxide (SO_3) per hundred square centimetres of exposed PbO_2 impregnated material per day (mg SO_3/100 cm^2/day). The method is normally used to detect the presence of sulphur dioxide, but other reactive sulphur compounds, such as H_2S may also be converted to the sulphate form. The Provincial criterion for sulphation is 0.7 mg SO_3/100 cm^2/day for a 30 day exposure.

Sulphation rate data from the Sault Ste. Marie survey were reported earlier (1) for the period 1970 to 1975. At that time, it was observed that the levels were low and had remained fairly constant at all sites. Of the 634 monthly samples collected during that time period, only 3 samples had marginally exceeded the Provincial criterion.

In this report all the data collected since the inception of the survey in 1970 are presented (see Tables 64 to 74). All values are reported in mg SO_3/100 cm^2/day. These data are summarized in Table 75, where the monitoring locations are ordered with increasing distance from the steel mill, the closest location being Beaver Hotel. Of the 912 monthly samples obtained from this survey during the period 1970 to 1978, only 12 samples exceeded the Provincial criterion of 0.70 mg SO_3/100

cm^2/day. These excessive values were obtained at sites within 2 km of the steel mill. The maximum value recorded was 1.60 mg SO_3/100 cm^2/day (Franklin St. Public School).

The mean sulphation rates were somewhat higher at the three closest sites to Algoma Steel, i.e. within about 1.28 km of the complex. This is shown in Figure 46, where the mean sulphation rates for the period 1970 to 1978 are plotted as a function of distance from the steel mill. For distances greater than about 1.5 km from the industrial complex, the mean sulphation levels were somewhat irregular, suggesting contributions from other sources. Inspection of the data presented in Tables 64 to 74 indicated higher sulphation levels during the colder months at all sites. This seasonal dependence strongly implicates contributions to the sulphation levels from residential and commercial space heating SO_2 emissions.

Consequently, on average, reactive sulphur compound emissions from Algoma Steel appear to increase sulphation levels by at most 0.2 mg SO_3/100 cm^2/day above the urban background levels in Sault Ste. Marie. However, these increased levels are well within the Provincial criterion.

VI FLUORIDATION RATE MONITORING PROGRAM:

The rate of fluoridation is determined by exposing calcium oxide (CaO) impregnated candles (analoguous to sulphation candles) to the ambient for 30-day periods. The calcium reacts with any fluoride compound that may be present, resulting in the formation of CaF_2. The lime paper bearing CaF_2 is then analyzed in the laboratory for determination of the amount of total fluorides present. Fluoridation rates are then determined and expressed in micrograms of total fluoride/100 cm^2 of limed candle surface/30 days. In Ontario the criteria for fluoridation are as follows:

40 ug F/100 cm^2/30 days - April 15 to October 15

80 ug F/100 cm^2/30 days - October 16 to April 14

These figures are based on vegetation damage and secondary effects on animals via forage.

Fluoridation rate data from the Sault Ste. Marie survey were reported earlier (1) for the period 1971 to 1975. At that time, it was observed that the levels were consistently higher at the Beaver Hotel and Bayview Public School sites, and that the levels at all monitoring sites had not changed appreciably from year to year. Of the 239 monthly samples collected during that time period, 20 samples had exceeded the Provincial criteria. Most of the excessive values (14 out of 20) had been collected at the Beaver Hotel and Bayview Public School sites.

In this report all the data collected since the start of the fluoridation survey in 1971 are presented (see Tables 76 to 81). A summary of the data is presented in Table 82, in which the monitoring locations were again ordered with increasing distance from the steel mill, the closest location being Beaver Hotel. Of the 370 monthly samples obtained from this survey since 1971, 27 samples exceeded the Provincial criteria. The majority of these excessive values (21 of 27) were obtained at sites within 1.5 km of the steel mill.

Figure 47 shows that the mean fluoridation levels near ($\leq$ 1.5 km) the steel mill were 28 ug F/100 cm^2/30d. At greater distances, the mean levels fell to 13 and 11 ug F/100 cm^2/30d. For comparison, fluoridation data collected at a downtown Sudbury location during the period 1972 to 1978 had a mean value of 13 ug F/100 cm^2/30d. Hence the levels in Sault Ste. Marie appear to be at urban background values at distances greater than about 1.5 km from the steel mill.

Consequently, fluoride emissions from Algoma Steel appear to increase mean fluoridation levels by about 15 ug F/100 cm^2/30d above urban background levels in Sault Ste. Marie.

VEGETATION AND SOIL SAMPLING PROGRAM (1976 and 1977)

a) Program Outline

A soil and vegetation sampling program was conducted in 1974 and 1975 (1). The samples collected in this program indicated that white birch foliage and soil collected within 1.5 km of the steel plant contained elevated concentrations of sulphur, fluoride, arsenic, iron and zinc.

In 1976, the sampling program was revised. Fourteen sites were selected at various distances and directions from the steel mill complex. In 1977, the number of sampling locations was increased to 20 and these locations are shown in Figure 48. The distance and direction of the sampling sites were measured from the centre of the steel mill complex, however, some sites may actually be closer to a specific contaminant source than indicated due to the large size of the complex.

Triplicate samples of Manitoba maple foliage and soil (0-10 cm) were collected at each site. Manitoba maple was substituted for white birch collected in earlier sampling programs because Manitoba maple was more frequently encountered in the urban environment surrounding the steel mill. Samples were returned to the laboratory for processing. They were dried, ground in a Wiley mill and chemically analysed for sulphur, iron, arsenic, manganese and zinc. In addition, the vegetation samples were analysed for fluoride and the soil samples were analysed for calcium and magnesium.

b) Excessive Values

The Ministry of the Environment has conducted numerous vegetation and soil sampling programs throughout the Province of Ontario. Based on experience with these programs as well as on data published in the literature, a set of guidelines has been developed to indicate the concentrations of individual chemical elements which are considered to be excessive in plant tissue and soil. "Excessive" does not necessarily mean toxic, but is evidence of contamination above average normal levels.

These guidelines are useful for many types of vegetation but may not be applied to all vegetation, particularly for those species which accumulate specific elements. The following values are used in this report.

CONCENTRATIONS CONSIDERED EXCESSIVE (ug/g)

ELEMENT	VEGETATION	SOIL
Arsenic	8	25
Iron	800	--
Fluoride	35	--
Manganese	500	1500
Zinc	250	400

c) Injury to Vegetation

At the time of sample collection, observations were made on the condition of vegetation in the area of the sample site. In 1976, the vegetation foliage at the west end of the Sault Locks (Site 19) was

found to exhibit trace or trace to light terminal necrosis. A very fine shiny particulate was also observed on the surface of the foliage. The species affected included Manitoba maple, white ash, white birch, willow and balsam poplar. Similar injuries were not noted at other locations. At the time of the 1977 collection, trace terminal necrosis was evident on foliage of several vegetation species, however, the injury was not confined to specific areas and showed no relationship to distance and direction from the steel mill.

d) Chemical Analyses Results for Vegetation

The results of the chemical analysis of the Manitoba maple foliage sampler are presented in Table 83. Sulphur concentrations do not show any pattern with relation to distance or direction of the steel mill. The two highest values are reported from Sites 19 and 20 which are in the southeasterly direction. The 1977 values were consistently higher than those reported for 1976 at corresponding locations.

The concentrations of iron in the foliage samples were considered to be excessive (greater than 800 ug/g) in one or more years at all sites except Sites 8, 11, 13 and 16. These sites are the most distant along radii to the north and east of the steel mill. The highest values were found at sites nearest to the steel mill and generally decreased with distance (Figure 49).

Manganese values were closely correlated with iron concentrations (Figure 50) however, none were considered to be excessive. Zinc

values tended to decrease with distance from the stell mill. The highest zinc concentrations were measured in samples collected at Sites 19 and 14, however, these were not considered to be excessive. Zinc concentrations in 1977 samples were consistently lower than those in 1976 samples.

The fluoride and arsenic content of the Manitoba maple samples followed a similar distribution pattern (Figure 51). The highest concentrations of each were measured at Sites 1, 4, 14, 19 and 20 which are nearest to the steel mill in the northwest and southeast directions. The fluoride content of the vegetation at these sites was considered to be excessive (greater than 35 ug/g), however, no sample contained excessive amounts of arsenic.

e) Chemical Analyses Results for Soil

The concentrations of the various chemical elements in soil are presented in Table 84. Soil samples from Site 3 (2375m W) and Site 11 (1525m NE) were found to contain excessive amounts of arsenic, zinc and manganese (Site 3 only) as well as elevated concentrations of iron and sulphur. Contaminants in these samples are considered to be related to a localized pocket of these elements in the soil and not from airborne emissions from Algoma Steel. If samples from Sites 3 and 11 are excluded from discussion, the concentrations of sulphur, iron, manganese, zinc, calcium and magnesium in the soil are rather variable and show no apparent relationship to location with respect to the steel mill. Soil collected at Site 18 (2150m ESE) in 1976 contained excessive

amounts of manganese, however, this is considered to be related to local contamination since normal concentrations of manganese were found at the same site in 1977. The arsenic content of soil samples collected at Sites 1, 14, 19 and 20 located in close proximity to the steel mill was elevated in relation to samples collected at more distant sites. This suggests that some arsenic from the steel mill is accumulating in the soil, however the concentrations are not considered to be excessive.

f) Summary

Vegetation (Manitoba maple) growing in the vicinity of the Algoma Steel operation was found to contain excessive amounts of iron and fluoride. The concentrations of iron, fluoride, arsenic, manganese and zinc in the foliage tended to decrease with distance from the steel mill. The highest concentrations of these elements, including sulphur, were usually measured at the west end of the Sault Locks. The injury to vegetation and particulate material on the foliage at this location in 1976 are consistent with the high fluoride and iron values measured in the samples.

The concentrations of various elements in soil were generally too variable to demonstrate any effects of the steel mill emissions on the soil, however, there was some indication that arsenic may be accumulating at some sites in close proximity to the mill.

VIII SNOW SAMPLING PROGRAM (1977)

a) Program Outline

On January 26 and 27, 1977, snow samples were collected for chemical analysis at 27 locations around the steel mill in Sault Ste. Marie. These locations are shown in Figure 52. In addition, samples were collected at 2 control locations east of Sault Ste. Marie.

The snow samples consisted of circular cores of snow (8 cm in diameter) and represented a complete profile of the snow from the surface to the ground level. The samples were taken in such a manner as to avoid contamination by ground materials. The number of cores required to fill 4.5 kg polyethylene bags was recorded. At the time of sampling, the total depth of snow was recorded as well as depth of fresh snow and the number of crust layers. Notes were made on the number and the type of any banding or layering in the snow profile.

The samples were returned to the laboratory and allowed to melt overnight at room temperature in the polyethylene bags. The presence of any precipitate in the melt water was noted and rated on an arbitrary scale of none to heavy. The volume of snow melt water was measured and a pH measurement taken immediately. The samples were divided into two equal portions and one of these portions was preserved by the addition of 2 ml of nitric acid. The acidified portion of the sample was analysed for iron, manganese, lead, aluminum, copper and zinc, while the non-acidified portion was analysed for sodium, potassium, calcium, magnesium, sulphate, arsenic and suspended solids.

b) Results of Snow Sampling

The condition and depth of snow measured at the sampling locations are summarized in Table 85. Snow depth ranged from 23 to 99 cm. Grey to black banding in the snow profile was evident at many of the stations but was more pronounced and more bands were present at those locations nearest the steel mill. The amount of black precipitate present in the snow-melt water could be related to the degree of banding in the snow profile.

The concentrations of various chemical elements and other parameters determined from the non-acidified snow melt water samples are presented in Table 86. Values reported for potassium, calcium, magnesium, sulphate, arsenic, alkalinity and suspended solids declined with distance from the steel mill. This trend is shown in Figures 53 to 55. The highest values were measured at Sites 1, 5, 17, 21 and 22 which are located nearest to the steel plant in the westerly and easterly directions. Sites 9 and 13, which represent the sites nearest to the steel mill in a northerly direction, had only slightly elevated values for the same parameters.

Sodium concentrations were mainly rather low and showed little relationship between the concentration and distance from the steel mill. The concentration variations probably reflect the proximity of the sampling site to roadways and salt-spray-drift. The low values measured are an indication that attempts to select sampling sites with the least possible influence of roadways, were mainly successful.

The pH values of the melt water tended to be quite high, particularly at sites nearest to the steel mill. Approximately one half of the samples had a pH of 8.0 or greater. The pH values did not demonstrate a clear trend of decreasing with distance as was shown by the alkalinity values.

The concentrations of chemical elements in the acidified portions of the snow melt water samples are listed in Table 87. The values for iron, manganese, lead, aluminum, copper and zinc showed a strong trend of decreasing with distance from the steel mill. The highest values were recorded at sites 1, 2, 5, 17, 21 and 25 which are the sites nearest the steel mill in the westerly and easterly directions. As was noted in the case of the non-acidified samples above, snow samples collected in the northerly direction from the steel mill were less contaminated than snow samples collected in other directions. In general all values for the acidified samples are low except for a limited number of samples which had slightly elevated concentrations of iron.

c) Summary

Snow samples collected in the vicinity of Algoma Steel Corporation were found to contain large amounts of suspended solid material. The amount of material decreased with distance from the steel mill. The concentrations of iron, manganese, lead, aluminum, copper, zinc, potassium, calcium, magnesium, sulphate, arsenic as well as alkalinity were highest near the steel mill and decreased with distance from the steel operation. Contamination of snow in the easterly and westerly

directions was found to be greater than in the northerly direction. The pH values of the snow were generally alkaline, probably due to the presence of the particulates in the samples. All indications are that the steel mill is the source of the contaminants in the snow.

1X ABATEMENT STRATEGY

The preceding information in this Report points to a number of air pollutant problems, especialy with regard to particulates. The Ministry of the Environment has in place a number of programs which are addressing these concerns.

Major reductions in particulates, measured by dustfall and high volume samplers, are expected within the next several years as a consequence of the existing Amending Control Order issued to Algoma Steel. Air pollution control equipment installations at the coke ovens, sinter plant and No. 1 steelmaking shop should alleviate existing local air pollution problems.

Control of charging and pushing emissions from the coke ovens should result in significant reductions in coal and coke braize discharges which make up a large fraction of the dustfall and hi-vol loadings in the area. PAH's are also associated with coke oven emissions. A new coke oven charge car has already been commissioned and is operating satisfactorily. Because of the disappointing results of the experimental water spray system employed by Algoma to control pushing emissions, more conventional emission control systems will be required. The first of these systems should be installed on No. 9 battery and be operational by mid-1982. Control of the remaining batteries will follow over a three or four year period.

A new baghouse treatment facility for the No. 1 steelmaking shop should markedly reduce graphite emissions from the shop's hot metal transfer station. Additional facilities to collect and treat fugitive emissions will result in reduced levels of fine iron particulates being discharged to the environment.

New treatment facilities at the Sinter Plant will control the discharge of fine iron particulates to acceptable levels. The facilities being considered will also reduce hydrocarbon and PAH emissions considerably.

Equipment required to control Sinter Plant and No. I Steelmaking Shop emissions is scheduled to be operating by early November I981.

The Ministry of the Environment will continue to monitor ambient air quality in Sault Ste. Marie to determine the effectiveness of the above abatement measures.

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XI APPENDIX

TABLE 1

AIR MONITORING STATION LOCATIONS AND PARAMETERS MONITORED IN SAULT STE. MARIE FROM 1976 TO 1978.

Station No.	Location	Distance (Km) and Direction From Algoma Steel	Pollutants Monitored * D	TSP	COH	SO_x	F	SO_2
71042	Bonney St.	0.80 NE	X	X				
71048	Sault Locks	0.96 SSE	X					
71010	Beaver Hotel **	0.96 SE	X			X	X	
71022	Soo College	1.02 SE	X	X	X	X	X	X
71043	Wilding Ave/Wallace Terr.	1.12 NNW	X					
71015	Bayview Public School	1.28 NW	X			X	X	
71044	Korah Rd/Wallace Terr.	1.28 NNE	X					
71045	Adelaide St.	1.52 NE	X					
71018	Franklin St. Public School	1.68 NE	X			X	X	
71019	S.F. Howe Public School	1.92 NE	X			X		
71017	Lady of Lourdes Separate School***	2.24 N	X			X	X	
71016	Holy Angels Separate School	2.40 ESE	X			X		
71013	James Lyons Public School	2.56 NE	X			X		
71049	Land Registry Office +	2.88 SE	X	X		X	X	X
71046	Fairview Avenue	3.36 NNE	X					
71047	People's Road	3.84 NNE	X					

Station No.	Location	Distance (Km) and Direction From Algoma Steel	Pollutants Monitored * D	TSP	COH	SO_X	F	SO_2
71014	Alexander Henry High School ++	4.64 NE	X			X		
71012	Anna McRae Public School	6.40 SE	X			X		

NOTES:

* D= Dustfall TSP= Total Suspended Particulate COH= Coefficient of Haze SO_X= Sulphation Rate F= Fluoridation Rate SO_2= Continuous SO_2 Analyzer

** Station relocated to Soo College in 1977.

*** Dustfall monitoring terminated in 1978.

\+ SO_2 analyzer and COH sampler relocated to Soo College in 1978.

++ Dustfall monitoring terminated in 1978.

TABLE 2

DATA ACQUISITION RECORD AND ANNUAL MEAN SO_2
LEVELS FOR MONITORING STATIONS IN SAULT STE. MARIE FROM 1976 TO 1978

	PERCENT VALID DATA			NO. OF READINGS			AVERAGE CONC. (ppm) **		
STATION	1976	1977	1978	1976	1977	1978	1976	1977	1978
Land Registry Office	61	75	I.D.*	1781	6559	389	.009	.007	I.D.
Soo College	----	----	87	----	----	7634	----	----	.008

NOTE:

* I.D. Insufficient data base. SO_2 monitor relocated to Soo College station on January 18, 1978.

** Provincial Criterion For SO_2:
Annual Avg.= 0.02 ppm.

TABLE 3

MAXIMUM MEAN SO_2 CONCENTRATION AND FREQUENCY OF EXCEEDANCE OF PROVINCIAL CRITERIA IN SAULT STE. MARIE FROM 1976 TO 1978

	1 Hr. Max. Conc.(ppm)			24 Hr. Max Conc. (ppm)			No. Of Times Above Provincial Criteria ** 1 Hr.			24 Hr.		
STATION	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
Land Registry Office	.09	.15	I.D.*	.03	.04	I.D.	NIL	NIL	I.D.	NIL	NIL	I.D.
Soo College	----	----	.75	----	----	.13	----	----	9	----	----	3

NOTE:

* I.D. Insufficient data base.

** Provincial Criteria for SO_2:
1 Hr. Avg.= 0.25 ppm
24 Hr. Avg.= 0.10 ppm

TABLE 4

DISTRIBUTION OF THE SULPHUR DIOXIDE HOURLY
READINGS RECORDED IN SAULT STE. MARIE FROM 1976 TO 1978

STATION	YEAR	NO. OF HOURLY READINGS IN STATED CONC. RANGE					
		0-0.10	0.11-0.25	0.26-0.49	0.50-0.99	≥ 1.00 ppm	TOTAL
Land Registry Office	1976	1781	0	0	0	0	1781
	1977	6556	3	0	0	0	6559
	1978	389	0	0	0	0	389
TOTAL		8726	3	0	0	0	8729
Soo College	1978	7587	38	6	3	0	7634

TABLE 5

SURFACE METEOROLOGICAL DATA FROM THE S.S. MARIE AIRPORT WEATHER OFFICE AND SO_2 DATA FROM THE SOO COLLEGE STATION DURING APRIL 11, 12 AND 13, 1978

DATE (1978)	HOUR (EST)	SO_2 Avg. Conc.(ppm)	Wind Speed(Km/hr)	Wind Direction
April 11	2200	0.21	26	270
	2300	0.30	24	270
	2400	0.48	20	260
April 12	0100	-*	26	250
	0200	0.75	26	260
	0300	0.59	24	250
	0400	0.35	26	240
April 13	0600	0.27	30	280
	0700	0.53	33	260
	0800	0.37	44	230
	0900	0.20	35	290

* SO_2 Analyzer Automatic Zero Check.

TABLE 6

TOTAL DUSTFALL LEVELS AT
STATION 71010 (BEAVER HOTEL) IN SAULT STE. MARIE FROM 1970 TO 1976
($GM/M^2/30$ DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	9.1	13.0	15.4	7.0	10.5	7.7	10.5
1971	7.7	15.1	15.1	21.7	---	8.1	23.5	7.0	13.3	7.7	32.9	9.8	14.7
1972	10.5	9.8	12.6	21.4	14.4	11.2	6.7	9.5	14.0	8.4	7.7	5.3	11.0
1973	11.6	7.0	18.9	24.5	12.6	13.0	10.9	10.5	9.5	15.4	16.1	5.6	13.0
1974	7.7	7.7	22.4	37.8	15.1	22.4	11.2	20.0	11.9	12.6	9.8	6.7	15.4
1975	6.7	5.6	11.2	23.8	15.4	11.2	18.2	16.5	11.2	6.3	10.9	8.1	12.1
1976	8.1	9.1	17.2	22.4	18.2	14.0	21.0	20.0	7.0	10.9	5.3	5.3	13.2
MEAN	8.7	9.1	16.2	25.3	15.1	13.3	14.4	13.8	11.8	9.8	13.3	6.9	13.0

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 $gm/m^2/30d$.
Station Relocated To The Soo College Site In 1977.

TABLE 7

TOTAL DUSTFALL LEVELS AT
STATION 71012 (ANNA McREA PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
($GM/M^2/30$ DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	3.2	6.7	3.9	1.8	0.7	1.1	2.9
1971	1.8	1.4	1.4	3.5	---	2.8	4.6	3.2	2.5	1.1	2.5	0.7	2.3
1972	1.1	1.1	0.7	---	4.6	1.4	2.1	3.2	2.5	2.8	1.8	1.1	2.0
1973	1.8	1.8	0.4	5.6	6.7	3.9	2.1	2.1	2.1	1.1	2.1	2.1	2.7
1974	1.4	1.1	2.1	4.9	4.6	3.2	1.4	1.4	1.4	2.5	2.1	1.8	2.3
1975	1.1	2.1	2.1	6.7	7.4	7.4	3.9	5.6	3.2	2.8	2.5	1.1	3.8
1976	2.1	1.8	3.2	3.5	3.5	4.6	2.1	1.8	1.8	2.1	1.1	1.1	2.4
1977	0.8	2.6	2.5	3.3	11.4	7.6	---	---	---	---	3.7	1.2	4.1
1978	1.3	1.8	1.5	3.4	5.5	1.7	1.0	2.6	3.2	1.5	1.4	1.1	2.4
MEAN	1.4	1.7	1.7	4.4	6.2	4.1	2.6	3.3	2.6	2.0	2.0	1.3	2.4

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 $gm/m^2/30d$.

TABLE 8

TOTAL DUSTFALL LEVELS AT
STATION 71013 (JAMES LYONS PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
($GM/M^2/30$ DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	7.4	6.7	7.7	3.2	3.9	2.1	5.2
1971	2.8	3.2	3.2	3.9	---	5.3	4.6	3.9	2.1	4.2	2.5	1.4	3.4
1972	1.4	3.9	---	---	3.2	1.8	---	7.0	3.5	3.2	3.5	1.4	3.2
1973	3.2	1.4	2.5	1.8	3.2	2.8	1.4	2.8	2.1	0.4	2.8	2.1	2.2
1974	2.5	1.8	3.9	4.2	2.8	3.2	1.1	1.4	4.2	2.5	2.8	2.5	2.7
1975	2.8	1.4	1.8	3.5	4.6	5.3	6.0	6.3	3.2	2.5	3.2	2.1	3.6
1976	3.2	3.5	4.2	3.5	3.5	4.6	3.9	5.6	3.9	3.2	2.1	2.1	3.6
1977	1.5	3.9	3.8	3.8	4.3	4.2	5.1	2.7	4.4	4.9	2.1	1.8	3.5
1978	1.7	2.5	---	4.8	4.6	3.3	0.1	7.7	3.2	1.5	1.4	1.1	3.5
MEAN	2.4	2.7	3.2	3.6	3.7	3.8	3.7	4.9	3.8	2.8	2.7	1.8	3.3

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 $gm/m^2/30d$.

TABLE 9

TOTAL DUSTFALL LEVELS AT
STATION 71014 (ALEXANDER HENRY HIGH SCHOOL) IN SAULT STE. MARIE FORM 1970 TO 1978
($GM/M^2/30$ DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	3.5	5.6	4.2	2.1	1.8	1.8	3.2
1971	2.8	3.9	3.9	---	---	4.2	---	2.5	4.6	2.5	1.4	3.2	3.2
1972	2.1	1.4	1.4	3.9	2.8	1.1	1.1	2.1	2.8	2.8	2.5	1.4	2.1
1973	1.8	1.1	1.1	0.7	2.5	3.9	1.4	1.8	1.8	0.4	1.1	3.5	1.8
1974	2.1	0.7	2.5	4.2	2.1	1.4	1.4	1.1	3.9	3.5	3.2	1.8	2.3
1975	2.5	1.1	1.1	3.2	3.9	5.3	3.5	---	---	3.9	3.2	1.8	3.0
1976	1.8	1.8	3.2	3.9	3.9	3.9	2.5	3.2	2.5	2.5	2.1	2.1	2.8
1977	1.3	2.9	3.0	2.9	---	3.0	3.4	2.5	1.4	2.0	3.9	1.3	2.5
1978	---	2.4	---	5.1	3.1	2.1	---	3.8	---	---	---	---	3.3
MEAN	2.1	1.9	2.3	3.4	3.1	3.1	2.4	2.8	3.0	2.5	2.4	2.1	2.6

NOTE:

--- Indicates data missing or invalid.
Station Terminated In August 1978.

TABLE 10

TOTAL DUSTFALL LEVELS AT
STATION 71015 (BAYVIEW PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
($GM/M^2/30$ DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	15.4	11.2	12.6	11.6	11.6	---	12.5
1971	11.2	6.7	6.7	9.5	---	6.7	6.7	8.4	9.5	8.1	3.2	4.9	7.4
1972	4.2	5.3	3.9	9.8	9.5	4.6	6.7	6.7	9.1	8.1	4.6	5.3	6.5
1973	6.3	8.4	6.0	10.5	8.1	10.2	6.0	11.2	8.8	3.9	9.8	7.4	8.1
1974	9.5	11.2	15.4	13.3	8.8	10.5	1.8	8.1	9.1	10.9	10.9	11.2	10.1
1975	22.1	15.4	12.6	14.4	13.3	19.3	11.2	12.3	11.6	11.9	11.6	7.7	13.6
1976	7.0	3.2	17.2	10.9	9.1	14.4	2.8	11.9	7.7	7.4	6.0	6.0	8.6
1977	6.7	8.3	13.2	9.6	10.4	7.0	13.9	10.9	10.5	12.6	15.6	3.6	10.2
1978	5.6	6.6	8.4	9.9	16.0	15.2	8.3	14.2	17.5	10.8	8.6	9.8	10.5
MEAN	9.1	8.1	10.4	11.0	10.7	11.0	8.1	10.5	10.7	9.5	8.0	7.0	9.5

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 $gm/m^2/30d$.

TABLE 11

TOTAL DUSTFALL LEVELS AT
STATION 71016 (HOLY ANGELS SEPARATE SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
($GM/M^2/30$ DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	3.5	---	4.9	3.5	2.1	3.9	3.6
1971	3.5	3.2	3.2	3.5	---	4.2	6.0	7.4	3.9	2.1	2.8	2.8	3.9
1972	1.8	2.5	2.5	4.6	4.9	2.1	---	3.5	6.0	2.8	3.5	1.8	3.3
1973	4.2	1.8	5.3	7.0	5.3	4.9	4.2	2.8	4.2	2.5	2.5	2.5	3.9
1974	3.5	2.5	9.8	8.4	6.7	5.3	12.3	3.9	2.8	4.9	6.0	5.3	6.0
1975	3.9	4.9	2.5	8.4	8.4	9.5	5.3	6.7	4.6	2.1	5.3	1.8	5.3
1976	3.2	3.5	5.3	8.4	7.0	6.0	6.7	6.0	3.9	4.2	2.8	2.8	5.0
1977	4.0	4.2	6.8	5.9	5.4	5.4	5.8	3.2	4.3	3.3	4.4	2.9	4.6
1978	3.0	4.7	5.9	9.1	5.0	5.6	3.6	3.6	5.0	3.1	2.3	2.7	5.1
MEAN	3.4	3.4	5.2	6.9	6.1	5.4	5.9	4.6	4.4	2.9	3.5	2.9	4.6

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 $gm/m^2/30d$.

TABLE 12

TOTAL DUSTFALL LEVELS AT
STATION 71017 (LADY OF LOURDES SEPARATE SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
($GM/M^2/30$ DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	---	4.6	3.5	4.2	4.2	3.2	3.9
1971	2.1	1.4	1.4	4.2	---	---	10.9	5.3	4.6	3.2	2.5	4.9	4.1
1972	2.1	1.1	1.8	6.0	3.9	1.1	---	---	3.9	3.9	3.2	2.5	3.0
1973	4.2	2.1	3.2	6.3	2.5	8.4	---	3.9	3.2	2.8	1.4	2.5	3.7
1974	2.5	1.8	3.5	12.6	3.2	6.3	2.5	3.5	2.1	2.8	2.8	6.3	4.2
1975	2.8	1.4	1.1	3.9	4.2	4.9	4.6	5.3	3.5	3.5	3.5	2.8	3.5
1976	2.5	2.5	4.2	4.2	4.9	5.6	7.7	4.2	3.2	3.2	2.5	2.5	3.9
1977	1.2	3.6	3.9	3.9	13.6	3.9	7.4	2.5	3.4	3.4	5.0	1.9	4.5
1978	---	2.4	---	3.9	4.1	40.1	---	---	---	---	---	---	---
MEAN	2.5	2.0	2.7	5.6	5.2	10.0	6.6	4.2	3.4	3.4	3.1	3.3	4.2

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 $gm/m^2/30d$.
Station Terminated In July 1978.

TABLE 13

TOTAL DUSTFALL LEVELS AT
STATION 71018 (FRANKLIN STREET PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
(GM/M^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	7.4	4.9	3.5	2.5	1.4	1.8	3.6
1971	3.5	3.5	3.5	3.2	---	2.8	4.9	3.9	2.8	2.8	2.1	1.8	3.2
1972	3.9	2.1	2.1	6.3	2.5	1.8	2.5	2.8	2.1	2.8	2.8	2.1	2.8
1973	3.5	1.4	2.8	3.2	3.5	4.6	3.2	3.2	2.1	1.1	2.8	1.8	2.8
1974	3.5	1.4	4.6	16.8	2.5	5.3	6.0	2.5	3.5	2.8	3.5	5.3	4.8
1975	3.2	1.8	1.4	4.2	5.6	6.3	4.9	5.3	4.2	3.5	---	3.2	4.0
1976	3.5	2.5	7.0	6.7	6.0	6.0	4.9	8.1	5.6	3.9	2.1	2.1	4.9
1977	2.2	2.9	5.7	6.3	5.6	3.9	6.6	5.2	4.2	4.6	4.2	1.7	4.4
1978	3.4	3.7	6.4	6.2	6.8	4.5	5.5	3.4	0.8	4.5	2.5	3.3	5.0
MEAN	3.3	2.4	4.2	6.6	4.6	4.4	5.1	4.4	3.2	3.2	2.7	2.6	3.9

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 gm/m^2/30d.

TABLE 14

TOTAL DUSTFALL LEVELS AT
STATION 71019 (S.F. HOWE PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
($GM/M^2/30$ DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	7.0	---	3.2	3.2	3.9	4.9	4.4
1971	4.9	4.2	4.2	2.1	---	7.4	6.0	4.6	2.8	4.6	2.8	3.5	4.3
1972	4.6	2.1	---	6.0	4.2	3.5	2.8	4.2	3.5	3.2	5.6	3.5	3.9
1973	4.6	2.1	3.2	2.5	3.5	3.2	3.5	---	3.2	1.4	3.9	4.2	3.2
1974	4.9	1.8	5.6	16.1	3.9	6.7	1.4	3.2	4.6	4.2	6.7	10.2	5.8
1975	6.7	2.5	2.8	4.9	7.4	6.3	4.9	4.9	3.5	4.2	---	---	4.8
1976	5.3	3.2	20.3	4.9	6.7	6.3	4.9	6.3	4.6	5.6	3.9	3.9	6.3
1977	2.8	1.9	6.1	6.4	5.9	4.9	6.5	3.2	4.7	3.9	6.3	4.9	4.8
1978	3.6	6.6	6.3	7.2	6.5	5.5	9.1	4.2	7.3	5.7	4.3	6.2	6.1
MEAN	4.7	3.1	6.9	6.3	5.4	5.5	5.1	4.4	4.2	4.0	4.7	5.2	4.9

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 $gm/m^2/30d$.

TABLE 15

TOTAL DUSTFALL LEVELS AT
STATION 71022 (SOO COLLEGE) SAULT STE. MARIE FROM 1977 TO 1978
(GM/M^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1977	8.5	10.0	11.9	16.4	11.0	11.7	15.7	10.3	13.7	11.5	6.3	7.0	11.2
1978	6.6	11.1	12.7	10.6	10.7	18.7	8.7	6.9	15.2	7.4	41.6	7.8	10.8
MEAN	7.6	10.6	12.3	13.5	10.9	15.2	12.2	8.6	14.5	9.5	24.0	7.4	11.0

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 gm/m^2/30d.

TABLE 16

TOTAL DUSTFALL LEVELS AT
STATION 71042 (BONNEY ST.) IN SAULT STE. MARIE FROM 1975 TO 1978
(GM/M^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1975	---	---	---	---	---	---	19.3	15.1	20.7	12.6	18.2	13.3	16.5
1976	11.2	13.7	18.2	---	12.3	24.9	9.1	13.7	9.8	9.8	10.2	10.2	13.0
1977	10.6	10.8	22.1	13.0	12.4	13.2	22.1	18.1	19.1	23.5	23.7	15.5	17.0
1978	13.1	2.0	12.5	5.4	22.3	20.9	17.8	18.0	9.4	14.4	13.2	---	14.0
MEAN	11.6	8.8	17.6	9.2	15.7	19.7	17.1	16.2	14.8	15.1	16.3	13.0	15.1

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 gm/m^2/30d.

TABLE 17

TOTAL DUSTFALL LEVELS AT
STATION 71043 (WILDING/WALLACE) IN SAULT STE. MARIE FROM 1975 TO 1978
($GM/M^2/30$ DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1975	---	---	---	---	---	---	11.2	8.8	8.1	1.1	---	5.3	6.9
1976	4.9	5.3	40.3	8.4	8.4	8.8	5.6	7.7	5.3	4.9	---	---	10.0
1977	4.1	---	8.9	6.2	7.9	15.2	11.0	6.2	9.6	6.4	---	4.4	8.0
1978	6.5	6.2	10.8	5.4	8.4	---	8.7	5.1	---	6.2	6.0	5.9	7.3
MEAN	5.2	5.8	20.0	6.7	8.2	12.0	9.1	7.0	7.7	4.7	6.0	5.2	8.3

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 $gm/m^2/30d$.

TABLE 18

TOTAL DUSTFALL LEVELS AT
STATION 71044 (KORAH/WALLACE) IN SAULT STE. MARIE FROM 1975 TO 1978
(GM/M^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1975	---	---	---	---	---	---	16.5	9.5	8.1	6.3	6.3	4.2	8.5
1976	3.9	2.8	9.8	15.4	10.5	9.5	7.4	10.2	8.8	7.7	4.2	4.2	7.9
1977	3.7	3.6	12.9	11.4	9.0	10.7	7.7	15.3	8.8	8.7	8.6	3.0	8.6
1978	4.6	7.0	14.2	11.6	5.4	5.7	11.2	6.0	7.5	7.1	4.5	3.8	8.2
MEAN	4.1	4.5	12.3	12.8	8.3	8.6	10.7	10.3	8.3	7.5	5.3	3.8	8.3

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 gm/m^2/30d.

TABLE 19

TOTAL DUSTFALL LEVELS AT
STATION 71045 (ADELAIDE ST.) SAULT STE. MARIE FROM 1975 TO 1978
(GM/M^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1975	---	---	---	---	---	---	13.3	6.7	6.3	5.3	4.6	---	7.2
1976	12.6	5.6	7.7	9.5	7.4	8.1	62.3	6.7	5.6	6.0	---	---	13.2
1977	4.2	94.9	10.1	8.0	7.1	6.6	11.6	7.5	10.9	6.0	6.6	4.4	14.8
1978	3.4	6.8	9.9	9.5	7.9	8.8	---	4.2	---	6.2	5.8	7.2	7.2
MEAN	6.7	35.8	9.2	9.0	7.5	7.8	29.1	6.3	7.6	5.9	5.7	5.8	11.7

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 gm/m^2/30d.

TABLE 20

TOTAL DUSTFALL LEVELS AT
STATION 71046 (FAIRVIEW AVE.) SAULT STE. MARIE FROM 1975 TO 1978
(GM/M^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1975	---	---	---	---	---	---	9.8	8.8	7.4	5.6	4.2	3.5	6.6
1976	4.2	16.8	6.0	9.8	9.5	22.4	6.0	7.7	6.0	4.9	3.9	3.9	8.4
1977	9.2	6.6	9.5	7.3	6.1	5.3	10.1	7.5	8.5	8.6	5.9	10.9	8.0
1978	7.3	---	10.5	6.7	9.7	16.1	7.9	7.1	50.1	8.4	---	3.8	9.3
MEAN	6.9	11.7	8.7	7.9	8.4	14.6	8.5	7.8	18.0	6.9	4.7	5.5	8.1

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 gm/m^2/30d.

TABLE 22

TOTAL DUSTFALL LEVELS AT
STATION 71048 (SAULT. LOCKS) SAULT STE. MARIE FROM 1975 TO 1978
(GM/M^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1975	---	---	---	---	---	---	13.3	9.1	6.3	2.5	2.5	2.1	6.0
1976	6.0	3.9	15.8	7.4	5.6	5.3	6.3	7.7	6.0	4.6	1.8	1.8	6.0
1977	3.9	5.5	6.2	5.3	3.9	9.2	8.1	7.1	5.5	4.9	5.5	2.3	5.6
1978	2.9	4.6	3.8	4.5	4.7	7.9	7.9	4.0	7.0	3.7	2.4	2.9	5.0
MEAN	4.3	4.7	8.6	5.7	4.7	7.5	8.9	7.0	6.2	3.9	3.1	2.3	5.7

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 gm/m^2/30d.

TABLE 21

TOTAL DUSTFALL LEVELS AT
STATION 71047 (PEOPLE'S RD.) SAULT STE. MARIE FROM 1975 TO 1978
(GM/M^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1975	---	---	---	---	---	---	6.0	6.3	---	4.9	6.3	3.2	5.0
1976	13.0	13.7	8.1	4.9	34.0	---	3.5	5.3	9.8	4.2	4.2	4.2	9.5
1977	14.8	1.7	4.9	4.0	6.3	3.5	---	6.4	5.1	5.4	4.2	---	5.6
1978	3.3	5.9	6.9	3.6	5.6	5.5	5.9	12.8	9.5	5.0	4.0	2.8	6.2
MEAN	10.4	7.1	6.6	4.2	15.3	4.5	5.1	7.7	8.1	4.9	4.7	3.4	7.0

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 gm/m^2/30d.

TABLE 23

TOTAL DUSTFALL LEVELS AT
STATION 71049 (LAND REG. OFFICE) IN SAULT STE. MARIE FROM 1975 TO 1978.
($GM/M^2/30$ DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1975	---	---	---	---	---	---	---	10.9	7.7	---	3.5	1.8	6.0
1976	2.5	2.5	5.6	7.0	5.6	4.2	7.7	7.4	3.2	3.2	1.4	1.4	4.3
1977	2.1	1.3	6.7	5.5	3.8	5.2	4.8	3.5	3.9	3.7	2.1	1.1	3.6
1978	1.6	2.9	2.0	8.1	3.8	4.8	4.5	2.3	5.4	2.7	2.0	1.0	3.8
MEAN	2.1	2.2	4.8	6.9	4.4	4.7	5.7	6.0	5.1	3.2	2.3	1.3	4.1

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the Provincial criterion of 7.0 $gm/m^2/30d$.

TABLE 24

ELEMENTAL ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71049 (LAND REGISTRY OFFICE) FROM
1976 TO 1978.

Element	No. of Samples	Average Value ($g/m^2/30d$)	Max. Value ($g/m^2/30d$)
Arsenic	10	B.D.L. *	0.0001
Copper	21	0.001	0.003
Iron	22	0.13	0.39
Lead	23	0.02	0.088
Nickel	25	0.001	0.003
Zinc	20	0.01	0.04

* Below detection limit of 0.0001 $g/m^2/30d$.

TABLE 25

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71010 (BEAVER HOTEL) IN SAULT STE. MARIE DURING 1976 *

SUBSTANCE	Feb.	Apr.	June	Aug.	Oct.	Dec.
Graphite	20	20	10	10	5	9
Coal and Coke	50	20	60	70	50	66
Iron Oxide	20	trace	trace			5
Road Dust (Silica) and Others	10	60	30	20	45	20

* All values are estimated volume %.

TABLE 26

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71012 (ANNA McRAE PUBLIC SCHOOL) IN SAULT STE. MARIE DURING 1976*

Substance	Feb.	Apr.	June	Aug.	Oct.	Dec.
Graphite	10	10	10	4	10	9
Coal and Coke	40	30	45	35	35	66
Iron Oxide	trace	N.D.	trace	1	---	5
Road Dust (Silica) and Others	50	60	45	60	55	20

*All values are estimated volume %.

N.D. : Below detection limit.

TABLE 27

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71012 (ANNA McRAE PUBLIC SCHOOL) IN SAULT STE. MARIE DURING 1977 *

SUBSTANCE	Jan.	Mar.	May	Nov.	Dec.
Graphite	3		1		1
Coal and Coke	62	46	50	19	82
Iron Oxide				3	
Biological Material				64	
Road Dust (Silica) and Others	35	54	39	14	17
Fly Ash			10		

* All values are estimated volume %.

TABLE 28

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71012 (ANNA McRAE PUBLIC SCHOOL) IN SAULT STE. MARIE DURING 1978 *

SUBSTANCE	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Graphite	29	13	1	4	18	27	9	11	26	15	12	3
Coal	6	7	3	4	5	5	1	7	2	2	4	6
Coke	21	33	20	22	40	12	16	19	25	69	16	36
Iron Oxide		1	1			2		3	3	1	16	6
Biological Material	4	6	10	17	16	33	51	10	34	6	20	30
Road Dust (Silica) and Others	6	32	26	52	19	19	22	48	8	6	11	5
Wood Char	22		38								18	
Fly Ash	12	8	1	1	2	2	1	2	2	1	3	14

* All values are estimated volume %.

TABLE 29

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71015 (BAYVIEW PUBLIC SCHOOL) IN SAULT STE. MARIE DURING 1976 *

SUBSTANCE	Feb.	Apr.	June	Aug.	Oct.	Dec.
Graphite	20	10	5	1	15	
Coal and Coke	60	80	75	80	70	95
Iron Oxide	10	trace	trace	trace		
Road Dust (Silica) and Others	10	10	20	19	15	5

* All values are estimated volume %.

TABLE 30

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71015 (BAYVIEW PUBLIC SCHOOL) IN SAULT STE. MARIE DURING 1977 *

SUBSTANCE	Jan.	Mar.	May	July	Sept.	Oct.	Nov.	Dec.
Graphite	1	1	5	10		10	trace	1
Coal and Coke	79	97	82	80	80	80	95 (coal=1)	97
Iron Oxide			5			5	1	trace
Biological Material			5	10	5	2	1	1
Road Dust (Silica) and Others	20	2	3	trace	15	3	3	1
Fly Ash							trace	

* All values are estimated volume %.

TABLE 31

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71015 (BAYVIEW PUBLIC SCHOOL) IN SAULT STE. MARIE DURING 1978 *

SUBSTANCE	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Nov.
Graphite	8	6	17	7	7	20	11	16	23	24
Coal	4	2	1	2	1	2	1	1	1	1
Coke	78	85	74	66	85	66	80	73	63	69
Iron Oxide	1	trace	trace	1		1	1	1	1	trace
Biological Material	3		4	7	2	5	5	7	6	1
Road Dust (Silica) and Others	3	2	3	15	4	4	1	1	5	3
Wood Char										1
Fly Ash	3	5	1	2	1	2	1	1	1	1

* All values are estimated volume %.

TABLE 32

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71042 (BONNEY ST.) IN SAULT STE. MARIE DURING 1976 *

SUBSTANCE	Feb.	June	Aug.	Oct.	Dec.
Graphite	10		2	1	3
Coal and Coke	80	55	85	60	95
Iron Oxide	5	trace	trace	1	
Road Dust (Silica) and Others	5	35	13	38	2

* All values are estimated volume %.

TABLE 33

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71042 (BONNEY ST.) IN SAULT STE. MARIE DURING 1977 *

SUBSTANCE	Jan.	Mar.	May	July	Sept.	Oct.	Nov.	Dec.
Graphite		10	1	2	2	10		1
Coal	90	80						
Coke			98	77	60	80	99	98
Iron Oxide	2			5		1		trace
Biological Material				15	28	5	1	
Road Dust (Silica) and Others	8	10	1	1	10	4		1

* All values are estimated volume %.

TABLE 34

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71042 (BONNEY ST.) IN SAULT STE. MARIE DURING 1978 *

SUBSTANCE	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Oct.	Nov.
Graphite	13	2	4	15	5	14	17	13	15	21
Coal	5	1	1	2	1	2	1	5	2	2
Coke	56	88	90	68	73	73	57	61	69	61
Iron Oxide	1	trace		2	2	1	1	4	1	2
Biological Material	3	trace		4	15	2	15	8	6	3
Road Dust (Silica) and Others	17	trace	3	6	4	6	7	8	6	4
Fly Ash	5	9	2	3		2	2	1	1	3

* All values are estimated volume %.

TABLE 35

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71043 (WILDING AVE/WALLACE TERR.) IN SAULT STE. MARIE DURING 1976 *

SUBSTANCE	Feb.	Apr.	June	Aug.	Oct.
Graphite	5	10		9	10
Coal and Coke	70	60	90	80	60
Iron Oxide	10	trace	trace	trace	
Road Dust (Silica) and Others	15	30	10	11	30

* All values are estimated volume %.

TABLE 36

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71043 (WILDING AVE/WALLACE TERR.) IN SAULT STE. MARIE DURING 1977 and 1978 *

	1977		1978
SUBSTANCE	Mar.	May	Dec.
Graphite	1	1	39
Coal and Coke	90	80 (Coal = 5)	31 (Coal = 7%)
Iron Oxide	1		3
Biological Material		5	18
Road Dust (Silica) and Others	8	14	3
Fly Ash			6

* All values are estimated volume %.

TABLE 37

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71044 (KORAH RD/WALLACE TERR.) IN SAULT STE. MARIE DURING 1976 & 1977 *

SUBSTANCE	1976						1977	
	Feb.	Apr.	June	Aug.	Oct.	Dec.	Mar.	May
Graphite	10	10		2	10	4	5	1
Coal and Coke	65	40	90	85	40	92	60	92
Iron Oxide	10	trace	trace	trace				
Biological Material								2
Road Dust (Silica) and Others	15	50	10	13	50	4	35	5

* All values are estimated volume %.

TABLE 38

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71044 (KORAH RD/WALLACE TERR.) IN SAULT STE. MARIE DURING 1978 *

SUBSTANCE	Feb.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Graphite	5	1	10	14	12	6	14	13	15	12
Coal	6	2	1	2	2	3	5	2	2	5
Coke	56	54	56	68	48	61	60	42	49	69
Iron Oxide	2	1	1	1	1	1	2	1	2	
Biological Material	4	9	23	3	25	22	7	8	7	2
Road Dust (Silica) and Others	9	30	7	10	10	5	10	13	13	3
Wood Char	1							9	5	
Slag								11	3	7
Fly Ash	17	3	2	2	2	2	2	1	1	2

* All values are estimated volume %.

TABLE 39

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71045 (ADELAIDE ST.) IN SAULT STE. MARIE DURING 1976 *

SUBSTANCE	Feb.	Apr.	June	Aug.	Oct.
Graphite	20	10	5	10	5
Coal and Coke	55	40	60	55	75
Iron Oxide	15	trace	trace		
Road Dust (Silica) and Others	10	50	35	35	20

* All values are estimated volume %.

TABLE 40

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71045 (ADELAIDE ST.) IN SAULT STE. MARIE DURING 1977 *

SUBSTANCE	Jan.	Mar.	May	July	Sept.	Oct.	Nov.	Dec.
Graphite		1	2	2		1	1	1
Coal and Coke	92	60	85	60	20	73	91	96
Iron Oxide			5	3	5	5	1	
Biological Material				32	50	5	1	
Road Dust (Silica) and Others	8	39	3	3	25	15	6	2
Wood Char			5					
Fly Ash						1		1

* All values are estimated volume %.

TABLE 41

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71045 (ADELAIDE ST.) IN SAULT STE. MARIE DURING 1978 *

SUBSTANCE	Jan.	Feb.	Mar.	Apr.	May	June	Aug.	Oct.	Nov.	Dec.
Graphite	13	10	11	5	15	14	20	21	19	14
Coal	5	9	4	2	7	3	6	2	3	4
Coke	69	52	59	32	43	42	46	59	46	60
Iron Oxide	2	1			1	1	1	2	1	
Biological Material	3	3	6	19	11	30	17	5	1	2
Road Dust (Silica) and Others	3	9	15	39	22	8	6	7	12	6
Wood Char		4		2			3		4	
Slag								3	12	10
Fly Ash	5	12	5	1	1	2	1	1	2	4

* All values are estimated volume %.

TABLE 42

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71046 (FAIRVIEW AVE.) IN SAULT STE. MARIE DURING 1978 *

SUBSTANCE	Feb.	Apr.	May	July	Sept.	Dec.
Graphite	4		1	3	1	7
Coal	2	1	1	1	1	5
Coke	11	1	13	5	5	8
Iron Oxide	1					1
Biological Material	1	8	3	5	27	3
Road Dust (Silica) and Others	5	1	15	7	28	4
Wood Char	59	64	61	51	25	57
Fly Ash	4	3	2	2	1	4
Wood Shavings	13	21	4	26	12	11

* All values are estimated volume %.

TABLE 43

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71047 (PEOPLE'S RD.) IN SAULT STE. MARIE DURING 1978 *

SUBSTANCE	Feb.	Apr.	May	June	July	Aug.	Sept.	Oct.	Dec.
Graphite	1	3	4	16	5	1	1	6	6
Coal	1	1	1	1	2	2	2	1	1
Coke	6	3	5	4	19	5	5	8	4
Iron Oxide					1	2	1	1	1
Biological Material	1	3	19	4	6	56	60	4	1
Road Dust (Silica) and Others	15	26	9	5	4	13	3	21	17
Wood Char	70	53	46	50	45	19	27	43	61
Fly Ash	2	1	2	2	2	2	1	2	1
Wood Shavings	4	10	14	18	16			14	8

* All values are estimated volume %.

TABLE 44

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71048 (SAULT LOCKS) IN SAULT STE. MARIE DURING 1976 *

SUBSTANCE	Feb.	Apr.	June	Aug.	Oct.	Dec.
Graphite	5	10	5	15	2	
Coal and Coke	30	40	60	60	50	62
Iron Oxide	50	5	5	1		1
Road Dust (Silica) and Others	15	45	30	24	48	37

* All values are estimated volume %.

TABLE 45

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71048 (SAULT LOCKS) IN SAULT STE. MARIE DURING 1977 *

SUBSTANCE	Jan.	Mar.	May	July	Sept.	Oct.	Nov.	Dec.
Graphite			1	5	1	10	1	
Coal	67	45				1	4	
Coke			64	28	65	75	73	42
Iron Oxide	1		25	20	5	5	2	
Biological Material				45	14	5	7	
Road Dust (Silica) and Others	32	55	10	2	15	4	12	57
Fly Ash							1	1

* All values are estimated volume %.

TABLE 46

OPTICAL MICROSCOPY ANALYSIS OF DUSTFALL SAMPLES
AT STATION 71048 (SAULT LOCKS) IN SAULT STE. MARIE DURING 1978 *

SUBSTANCE	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Graphite	2	4	2	8	17	13	11	11	9	13	19
Coal	4	2	2	3	3	3	7	4	4	2	2
Coke	47	30	23	58	54	49	60	34	36	60	16
Iron Oxide	3	2	2	2	3	1	3	2	13	7	1
Biological Material	10	6		3	2	27	2	18	3	1	2
Road Dust (Silica) and Others	5	49	48	16	10	4	13	23	19	4	12
Wood Char	21	2	10	6	7	1		6			
Slag	1								11	12	46
Fly Ash	5	1	1	2	3	2	4	2	7	1	2
Foundry Sand	2	4	12	2	1						

* All values are estimated volume %.

TABLE 47

SUMMARY OF TOTAL SUSPENDED PARTICULATE DATA
COLLECTED IN SAULT STE. MARIE DURING 1976, 1977 AND 1978.

	No. of Samples			Geometric Mean(ug/m^3)*			Max. 24-Hr. Value(ug/m^3)			No. of Samples Above Provincial Criterion*		
Location	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
Land Registry Office	29	38	32	44	38	38	182	101	114	3	NIL	NIL
Soo College	22	50	48	72	64	64	250	378	198	4	5	7
Bonney St.	76	41	34	97	107	102	494	563	584	30	20	15
TOTAL	127	129	114							37	25	22

*Provincial Criterion:

Annual: 60 ug/m^3 (Geometric Mean)

24-Hour: 120 ug/m^3

TABLE 48a

SUMMARY OF TOTAL SUSPENDED PARTICULATE DATA COLLECTED IN SAULT STE. MARIE FROM 1976 TO 1978.*

Location	No. of Samples	Geometric Mean	Geometric Standard Deviation	Min. Value	Max. Value
Land Registry Office	99	40	1.80	14	182
Soo College	120	66	1.78	19	378
Bonney Street	151	103	2.11	13	584

*All values are in ug/m^3

Table 48b

SEASONAL VARIATION IN TSP LEVELS IN SAULT STE. MARIE
FROM 1975 to 1978

	SEASON						
	SUMMER			WINTER			
Location	No. of Samples	Geometric Mean (ug/m^3)	Geometric Stand. Dev. (ug/m^3)	No. of Samples	Geometric Mean (ug/m^3)	Geometric Stand. Dev. (ug/m^3)	Significant Difference**
Bonney St.	130	115	2.05	85	77	2.35	yes
Land Registry Office	60	57	1.75	62	32	1.59	yes
Soo College*	72	66	1.79	48	65	1.76	no

* Station installed in September 1976

** Significant Difference at the 1% level.

TABLE 49

HEAVY METAL ANALYSIS OF HIGH VOLUME AIR FILTERS EXPOSED IN SAULT STE. MARIE FROM 1976 TO 1978.

Element	Station*	No. of Samples Analyzed			Geometric Mean (ug/m^3)			Max Value (ug/m^3)
		1976	1977	1978	1976	1977	1978	
Cu	71049	25	40	31	0.40	0.41	0.48	1.23
	71022	16	46	53	0.34	0.23	0.28	1.36
	71042	16	34	32	0.15	0.56	0.22	4.63
Fe	71049	25	41	31	2.0	1.0	1.4	43.6
	71022	15	47	45	4.3	4.9	3.8	58.7
	71042	15	34	32	6.3	6.1	9.7	99.3
Pb	71049	30	41	31	0.5	0.4	0.3	1.2
	71022	15	47	45	0.5	0.3	0.3	0.9
	71042	28	34	32	0.3	0.3	0.3	1.2
Mn	71049	--	--	28	---	---	0.06	0.55
	71022	--	--	34	---	---	0.28	2.27
	71042	--	12	32	---	0.87	0.82	5.12
Ni	71049	25	41	31	0.006	0.003	0.008	0.046
	71022	16	46	45	0.003	0.004	0.007	0.039
	71042	15	34	32	0.005	0.005	0.010	0.066

*71049: Land Registry Office
71022: Soo College
71042: Bonney St.

-Insufficient data to report a mean

TABLE 50

HEAVY METAL ANALYSIS OF HIGH VOLUME AIR FILTERS EXPOSED IN SAULT STE. MARIE FROM 1976 TO 1978.

Element	Station	No. of Samples	Geometric Mean*	Geometric Standard Deviation*	No. of Samples Above Provincial Criterion**
Cu	71049	96	0.43	0.02	Nil
	71022	115	0.27	0.02	Nil
	71042	82	0.30	0.03	Nil
Fe	71049	97	1.8	0.33	1
	71022	107	4.2	0.26	1
	71042	81	7.3	0.26	7
Pb	71049	102	0.4	0.2	Nil
	71022	107	0.3	0.2	Nil
	71042	94	0.3	0.2	Nil
Mn	71049	28	0.06	0.03	Nil
	71022	34	0.28	0.02	Nil
	71042	44	0.83	0.02	Nil
Ni	71049	97	0.005	0.004	Nil
	71022	107	0.005	0.003	Nil
	71042	81	0.007	0.004	Nil

TABLE 50 continued

*Values are in ug/m^3

**Provincial 24 - hr. criteria:

Cu: 50 ug/m^3 (based on health effects)

Fe (as Fe_2O_3): 25 ug/m^3 (based on soiling effects)

Pb: 5 ug/m^3 (based on health effects)

Mn: 50 ug/m^3 (based on health effects)

Ni: 2 ug/m^3 (based on vegetation damage and health effects)

TABLE 51

COMPARATIVE ANALYSIS OF HEAVY METAL CONCENTRATIONS
ON HI-VOL FILTERS EXPOSED IN SAULT STE. MARIE FROM 1976 TO 1978.

Stations Compared	Significant Difference (5% level)				
	Cu	Fe	Pb	Mn*	Ni
Land Registry - Soo College	Yes (higher)	Yes (lower)	No	Yes (lower)	No
Land Registry - Bonney St.	Yes (higher)	Yes (lower)	No	Yes (lower)	No
Soo College - Bonney St.	No	Yes (lower)	No	Yes (lower)	No

Noter: (   ) indicates higher or lower levels at the station underlined

*1978 data only

TABLE 52

SUMMARY OF SULPHATE AND NITRATE PARTICULATE DATA
COLLECTED AT THE BONNEY ST. STATION FROM 1976 TO 1978.

	No. of Samples		Geometric Mean (ug/m^3)		Max. Value (ug/m^3)		Min. Value (ug/m^3)	
Year	$SO_4^=$	NO_3^-	$SO_4^=$	NO_3^-	$SO_4^=$	NO_3^-	$SO_4^=$	NO_3^-
1976	33	35	9.4	1.5	28.4	15.1	1.6	0.1
1977	40	41	12.6	1.1	94.9	17.7	2.6	0.1
1978	34	34	10.8	1.2	40.4	5.3	2.5	0.3
Total	107	110						

TABLE 53

SUMMARY OF FREE AND TOTAL CARBON HI-VOL DATA COLLECTED IN SAULT STE. MARIE DURING 1977.

Station	No. of Samples	Maximum Value (ug/m^3)		Geometric Mean (ug/m^3)	
		Total Carbon	Free Carbon	Total Carbon	Free Carbon
Bonney St.	29	97.1	48.5	18.5	9.5
Soo College	31	31.5	13.3	9.5	5.6
Land Registry	19	16.3	12.9	7.2	4.1

TABLE 54

SUMMARY OF B(a)P AND B(k)F DATA
COLLECTED IN SAULT STE. MARIE FROM 1975 TO 1978

Station	No. of Samples		Geometric Mean (ug/1000m^3)	
	B(a)P	B(k)F	B(a)P	B(k)F
Bonney St.	68	68	1.12	1.77
Soo College	49	49	1.00	1.03
Land Registry Office	69	69	0.23	0.43

TABLE 55

SEASONAL VARIATION IN BaP LEVELS (ug/1000m^3)
IN SAULT STE. MARIE FROM 1975 TO 1978.

Location	Heating		Non-Heating		
	No. of Samples	Geometric Mean*	No. of Samples	Geometric Mean*	Significant Difference**
Bonney Street	28	1.34	40	0.98	no
Land Registry Office	37	0.24	32	0.23	no
Soo College	25	1.67	24	0.59	no

*All values in ug/1000m^3

**Significant Difference at the 1% level

TABLE 56

SUMMARY OF PAH DATA
COLLECTED DURING 1977 AND 1978 IN SAULT STE. MARIE

PAH Compound	Station	No. of Samples	Geometric Mean (ug/1000m^3)	Max. Value (ug/1000m^3)
Benzo(a)Pyrene	Bonney Street	19	1.71	95.9
	Soo College	31	0.70	24.7
	Land Registry Office	25	0.25	7.9
Benzo(k)Fluoranthene	Bonney Street	19	1.79	56.5
	Soo College	31	0.61	12.7
	Land Registry Office	25	0.25	3.9
Fluoranthene	Bonney Street	19	2.89	27.4
	Soo College	31	1.21	13.0
	Land Registry Office	25	0.68	4.8
Perylene	Bonney Street	19	3.66	106.0
	Soo College	31	1.29	30.8
	Land Registry Office	25	0.47	9.1
Benzo(ghi)Perylene	Bonney Street	19	3.88	90.0
	Soo College	31	1.74	29.6
	Land Registry Office	25	0.96	8.5

TABLE 57

POLYNUCLEAR AROMATIC HYDROCARBONS ON ANDERSEN FILTERS COLLECTED IN SAULT STE. MARIE IN AUGUST 1977*

Location	Date (1977)	Impactor Stage No.	Effective Cut-Off Particle Diameter (microns)		TSP (ug/m^3)	BaP	BkF	Fluoranthene	Perylene	B(ghi)P
Soo	August 23	1	≥ 7.0		19.7	0.06	0.05	0.02	0.05	0.13
College		2	3.3-7.0		12.3	0.10	0.08	0.15	0.10	0.34
		3	2.0-3.3		3.4	0.12	0.10	0.13	0.17	0.74
		4	1.1-2.0		6.2	0.34	0.24	0.20	0.33	0.63
		Back-up Filter	1.0		14.2	0.47	0.43	0.39	0.63	2.87
				Total	55.8	1.09	0.90	0.89	1.28	4.71
Bonney	August 24	1	≥ 7.0		30.4	0.12	0.10	0.20	0.13	0.23
Street		2	3.3-7.0		4.3	0.07	0.05	0.15	0.07	0.11
		3	2.0-3.3		8.3	0.01	0.03	0.07	0.03	0.14
		4	1.1-2.0		3.1	0.03	0.02	0.08	0.03	0.17
		Back-up Filter	≤ 1.0		5.0	0.11	0.07	0.13	0.05	0.45
				Total	51.1	0.34	0.27	0.63	0.31	1.10
Sault	August 25	1	≤ 7.0		11.9	0.05	0.04	0.14	0.04	0.09
Locks		2	3.3-7.0		7.0	0.05	0.02	0.12	0.03	0.08
		3	2.0-3.3		7.5	n.d.	n.d.	n.d.	n.d.	n.d.
		4	1.1-2.0		4.6	0.04	0.02	0.10	0.03	0.20
		Back-up Filter	≤ 1.0		4.3	0.08	0.08	0.25	0.07	0.16
				Total	35.3	0.22	0.16	0.61	0.17	0.53

TABLE 57

POLYNUCLEAR AROMATIC HYDROCARBONS ON ANDERSEN FILTERS COLLECTED IN SAULT STE. MARIE IN AUGUST 1977*

Location	Date (1977)	Impactor Stage No.	Effective Cut-Off Particle Diameter (microns)	TSP (ug/m^3)	BaP	BkF	Fluoranthene	Perylene	B(ghi)P
Whitefish Island	August 23	1	7.0	65.1	0.12	0.15	0.16	0.16	0.34
		2	3.3-7.0	34.7	0.20	0.15	0.21	0.20	0.45
		3	2.0-3.3	20.0	0.94	0.21	0.21	0.36	1.48
		4	1.1-2.0	13.6	0.53	0.37	0.14	0.52	1.14
		Back-up Filter	1.0	30.6	0.51	0.89	0.23	1.41	4.38
			Total	164.0	2.30	1.77	0.95	2.65	7.79
Whitefish Island	August 24	1	≥ 7.0	73.2	0.09	0.13	0.17	0.14	0.45
		2	3.3-7.0	37.4	0.34	0.27	0.12	0.35	10.90
		3	2.0-3.3	26.9	0.64	0.57	0.28	0.91	2.72
		4	1.1-2.0	17.2	1.28	0.85	0.33	1.26	2.18
		Back-up Filter	≤ 1.0	36.7	0.77	1.37	1.10	1.72	3.28
			Total	191.4	3.12	3.19	2.00	4.38	19.53
Sault Locks	August 25	1	≥ 7.0	16.7	0.02	0.02	0.07	0.02	0.01
		2	3.3-7.0	5.9	0.02	0.01	0.03	0.01	0.03
		3	2.0-3.3	7.0	0.03	0.02	0.05	0.02	0.01
		4	1.1-2.0	3.6	0.01	0.01	0.05	0.01	0.01
		Back-up Filter	≤ 1.0	3.1	0.01	0.01	0.01	0.01	0.01
			Total	36.3	0.09	0.07	0.21	0.07	0.07

*All PAH values are in $ug/1000m^3$
n.d. : Not determined

TABLE 58

POLYNUCLEAR AROMATIC HYDROCARBONS ON ANDERSEN FILTERS COLLECTED IN SAULT STE. MARIE IN JUNE 1978*

Location	Date (1978)	Impactor Stage No.	Effective Cut-Off Particle Diameter (microns)	TSP (ug/m^3)	BaP	BkF	Fluoranthene	Perylene	B(ghi)P
Soo	June 20	1	7.0	8.9	0.08	0.05	0.18	0.07	0.10
College		2	3.3-7.0	7.5	0.03	0.01	0.08	0.02	0.05
		3	2.0-3.3	4.1	0.02	0.01	0.05	0.01	0.04
		4	1.1-2.0	2.2	0.03	0.01	0.05	0.01	0.05
		Back-up Filter	1.0	8.8	0.08	0.04	0.17	0.06	0.18
			Total	31.5	0.24	0.12	0.53	0.17	0.42
Soo	June 21	1	7.0	18.6	0.17	0.16	0.41	0.20	0.19
College		2	3.3-7.0	8.9	0.09	0.10	0.28	0.13	0.16
		3	2.0-3.3	5.8	0.16	0.14	0.14	0.18	0.43
		4	1.1-2.0	3.8	0.24	0.16	0.12	0.23	0.24
		Back-up Filter	1.0	11.2	0.16	0.22	0.14	0.30	0.93
			Total	48.3	0.82	0.78	1.09	1.04	1.95
Soo	June 22	1	7.0	37.9	0.20	0.24	0.78	0.30	0.36
College		2	3.3-7.0	19.5	0.19	0.15	0.51	0.19	0.33
		3	2.0-3.3	10.4	0.20	0.18	0.52	0.23	0.42
		4	1.1-2.0	6.8	0.08	0.09	0.22	0.12	0.30
		Back-up Filter	1.0	24.2	0.39	0.36	0.84	0.49	1.56
			Total	98.8	1.06	1.02	2.87	1.33	2.97

TABLE **58** continued

POLYNUCLEAR AROMATIC HYDROCARBONS ON ANDERSEN FILTERS COLLECTED IN SAULT STE. MARIE IN JUNE 1978*

Location	Date (1978)	Impactor Stage No.	Effective Cut-Off Particle Diameter (microns)		TSP (ug/m^3)	BaP	BkF	Fluoranthene	Perylene	B(ghi)P
Baseline	June 20	1	7.0		104.3	0.13	0.19	0.28	0.31	0.44
West		2	3.3-7.0		43.0	0.13	0.13	0.28	0.23	0.45
		3	2.0-3.3		18.6	0.07	0.05	0.11	0.07	0.34
		4	1.1-2.0		15.9	0.07	0.06	0.12	0.10	0.17
		Back-up Filter	1.0		39.5	0.10	0.13	0.33	0.24	0.64
				Total	221.3	0.50	0.56	1.12	0.95	2.04
Sault	June 21	1	7.0		81.9	0.35	0.40	0.32	0.67	0.97
Locks		2	3.3-7.0		46.1	0.54	0.50	0.29	0.85	1.94
		3	2.0-3.3		23.5	0.59	0.51	0.20	0.85	2.30
		4	1.1-2.0		19.1	1.05	0.88	0.24	1.44	2.54
		Back-up Filter	1.0		40.8	0.53	2.37	0.52	4.06	6.98
				Total	211.4	3.06	4.66	1.57	7.87	14.73
Sault	June 22	1	$\geq$ 7.0		76.7	0.29	0.37	0.46	0.57	0.88
Locks		2	3.3-7.0		46.1	0.51	0.37	0.30	0.64	1.33
		3	2.0-3.3		27.1	1.02	0.63	0.34	1.06	2.00
		4	1.1-2.0		23.3	2.01	1.23	0.54	2.16	3.28
		Back-up Filter	1.0		46.9	n.d.	1.66	0.37	3.14	6.83
				Total	220.1	3.83	4.26	2.01	7.57	14.32

*All PAH values are in $ug/1000m^3$

n.d. : Not determined

TABLE 59

WEIGHT DISTRIBUTION (%) OF PAH COMPOUNDS ON ANDERSEN* FILTERS COLLECTED IN SAULT STE. MARIE IN AUGUST 1977.

Location	Date (1977)	Impactor Stage No.	Effective Cut-Off Particle Diameter (microns)	TSP (ug/m^3)	BaP	BkF	Fluoranthene	Perylene	B(ghi)P
Soo College	August 23	1	≥ 7.0	35	6	5	2	4	3
		2	3.3-7.0	22	9	9	17	8	7
		3	2.0-3.3	6	11	11	15	13	16
		4	1.1-2.0	12	31	27	22	26	13
		Back-up Filter	≤ 1.0	25	43	48	44	49	61
Bonney Street	August 24	1	≥ 7.0	60	35	37	32	42	21
		2	3.3-7.0	8	21	18	23	22	10
		3	2.0-3.3	16	3	11	11	10	13
		4	1.1-2.0	6	9	8	13	10	15
		Back-up Filter	≤ 1.0	10	32	26	21	16	41
Sault Locks	August 25	1	≥ 7.0	34	23	25	23	23	17
		2	3.3-7.0	20	23	12	20	18	15
		3	2.0-3.3	21	n.d.	n.d.	n.d.	n.d.	n.d.
		4	1.1-2.0	13	18	12	16	18	38
		Back-up Filter	≤ 1.0	12	36	51	41	41	30

TABLE 59 continued

WEIGHT DISTRIBUTION (%) OF PAH COMPOUNDS ON ANDERSEN FILTERS COLLECTED IN SAULT STE. MARIE IN AUGUST 1977.*

Location	Date (1977)	Impactor Stage No.	Effective Cut-Off Particle Diameter (microns)	TSP (ug/m^3)	BaP	BkF	Fluoranthene	Perylene	B(ghi)P
Whitefish Island	August 23	1	≥7.0	38	5	8	17	6	4
		2	3.3-7.0	21	9	8	22	7	6
		3	2.0-3.3	13	41	13	22	14	19
		4	1.1-2.0	9	23	21	15	20	15
		Back-up Filter	≤1.0	19	22	50	24	53	56
Whitefish Island	August 24	1	≥7.0	38	3	4	8	3	2
		2	3.3-7.0	20	10	8	6	8	56
		3	2.0-3.3	14	21	18	14	21	14
		4	1.1-2.0	9	41	27	17	29	11
		Back-up Filter	≤1.0	19	25	43	55	39	17
Sault Locks	August 25**	1	≥7.0	46	22	29	33	28	14
		2	3.3-7.0	16	22	14	14	15	44
		3	2.0-3.3	19	33	29	24	28	14
		4	1.1-2.0	10	11	14	24	15	14
		Back-up Filter	≤1.0	9	11	14	5	14	14

*All values are in weight percent

**Very small amount of PAH material collected

n.d. : Not determined

TABLE 60

WEIGHT DISTRIBUTION (%) OF PAH COMPOUNDS ON ANDERSEN FILTERS COLLECTED IN SAULT STE. MARIE IN JUNE 1978.

Location	Date (1978)	Impactor Stage No.	Effective Cut-Off Particle Diameter (microns)	TSP (ug/m^3)	BaP	BkF	Fluoranthene	Perylene	B(ghi)P
Soo	June 20	1	≥ 7.0	28	33	42	34	41	24
College		2	3.3-7.0	24	13	8	15	12	12
		3	2.0-3.3	13	8	8	9	6	10
		4	1.1-2.0	7	13	8	9	6	12
		Back-up Filter	< 1.0	28	33	34	33	35	42
Soo	June 21	1	7.0	38	21	21	38	19	10
College		2	3.3-7.0	18	11	12	26	12	8
		3	2.0-3.3	12	19	18	13	17	22
		4	1.1-2.0	9	30	21	10	23	12
		Back-up Filter	1.0	23	19	28	13	29	48
Soo	June 22	1	≥ 7.0	38	18	24	27	23	12
College		2	3.3-7.0	18	18	15	18	14	11
		3	2.0-3.3	11	18	18	18	17	14
		4	1.1-2.0	8	9	9	8	9	10
		Back-up Filter	< 1.0	25	37	34	29	37	53

TABLE 60 continued

WEIGHT DISTRIBUTION (%) OF PAH COMPOUNDS ON ANDERSEN FILTERS COLLECTED IN SAULT STE. MARIE IN JUNE 1978.

Location	Date (1978)	Impactor Stage No.	Effective Cut-Off Particle Diameter (microns)	TSP (ug/m^3)	BaP	BkF	Fluoranthene	Perylene	B(ghi)P
Baseline	June 20	1	7.0	47	26	34	25	33	22
West		2	3.3-7.0	19	26	23	25	24	22
		3	2.0-3.3	8	14	9	10	7	17
		4	1.1-2.0	8	14	11	11	11	8
		Back-up Filter	1.0	18	20	23	29	25	31
Sault	June 21	1	7.0	39	11	9	20	8	7
Locks		2	3.3-7.0	22	18	11	18	11	13
		3	2.0-3.3	11	19	11	14	11	16
		4	1.1-2.0	9	35	18	15	18	17
		Back-up Filter	1.0	19	17	51	33	52	47
Sault	June 22	1	≥ 7.0	35	8	9	23	8	6
Locks		2	3.3-7.0	21	13	9	15	8	9
		3	2.0-3.3	12	27	14	17	14	14
		4	1.1-2.0	11	52	29	27	28	23
		Back-up Filter	≤ 1.0	21	n.d.	39	18	42	48

n.d. : Not determined

*All values are in weight percent

TABLE 61

POLYNUCLEAR AROMATIC HYDROCARBONS ON HIGH VOLUME FILTERS
COLLECTED IN SAULT STE. MARIE IN JUNE 1978*

Location	Date (1978)	TSP (ug/m^3)	BaP	BkF	Fluoranthene	Perylene	B(ghi)P
Soo	June 20	99.7	1.25	1.03	0.74	1.49	1.56
College	June 21	130.0	3.21	2.52	2.40	3.80	4.47
	June 22	181.8	1.98	2.38	2.81	3.55	4.93
Bonney	June 20	139.3	1.25	1.21	0.84	1.91	2.26
Street	June 21	55.3	0.14	0.23	0.38	0.33	0.45
	June 22	69.6	0.28	0.24	0.48	0.36	0.67
Land Registry	June 20	59.1	0.10	0.12	0.24	0.19	0.37
Office	June 21	48.3	0.24	0.20	0.22	0.33	0.68
	June 22	60.6	0.51	0.33	0.28	0.58	1.79

*All PAH values are in $ug/1000m^3$

TABLE 62

SUMMARY OF THE SOILING READINGS
COLLECTED IN SAULT STE. MARIE FROM 1976 TO 1978.*

Location	Maximum Value** 1976	Maximum Value** 1977	Maximum Value** 1978	Maximum 24-Hr Avg. 1976	Maximum 24-Hr Avg. 1977	Maximum 24-Hr Avg. 1978	Annual Average 1976	Annual Average 1977	Annual Average 1978
Land Registry Office	1.4	1.9	I.D.	0.5	0.5	I.D.	0.19	0.21	I.D.
Soo College	---	---	2.5	---	---	1.1	---	---	0.28

*All values are in COH units/1000ft. of air
**2Hr. Samples
I.D. : Insufficent Data
---COH monitor installed in 1978

TABLE 63

MONTHLY AVERAGE SOILING LEVELS
IN SAULT STE. MARIE FROM 1976 TO 1978*

Location	Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
Land Registry**	1976	---	---	---	0.31	---	---	0.19	0.19	0.18	0.20	0.17	0.16
Office	1977	0.18	0.17	0.20	0.18	0.20	0.18	0.20	0.20	0.20	0.26	0.19	0.27
Soo College	1978	0.36	0.32	0.34	---	0.32	0.22	0.20	0.22	0.24	0.31	0.33	0.35

*All values are in COH units/1000ft. of air

**Monitor installed in April 1976

---Data Unavailable

TABLE 64

SULPHATION RATES ON THE LEAD PEROXIDE CANDLES AT STATION 71010 (BEAVER HOTEL) IN SAULT STE. MARIE FROM 1970 TO 1976 (ALL VALUES IN MGM SO_3/100 CM^2/DAY)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	.11	---	.36	.34	.31	.60	.34
1971	.72	.39	.39	.31	.30	.11	.23	.19	.20	.27	.37	.67	.35
1972	.43	.40	.25	.37	.17	.12	.11	.08	.25	.29	.39	.53	.28
1973	.30	.21	---	---	.14	.10	.18	.45	.19	.47	.16	.22	.24
1974	.13	.23	.49	.21	.20	.15	.21	.24	.21	.06	.71	.27	.26
1975	.41	.44	.30	.28	.17	.19	.20	.21	.23	.41	.49	.36	.31
1976	.54	.19	.61	.20	.18	.19	.23	.15	.20	.38	.31	.31	.29
MEAN	.42	.31	.41	.27	.19	.14	.18	.18	.23	.32	.39	.42	.30

NOTE:

--- Indicates data missing or invalid.

TABLE 65

SULPHATION RATES ON THE LEAD PEROXIDE CANDLES AT
STATION 71012 (ANNA McREA PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
(ALL VALUES IN MGM SO_3/100 CM^2/DAY)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	.05	.03	.07	.16	.17	.43	.15
1971	.26	.34	.34	.17	.18	.11	.08	.08	.06	.14	.14	.21	.18
1972	.26	.33	.14	.17	.18	.07	.05	.05	.07	.11	.15	.25	.15
1973	.15	.14	.15	---	.17	.02	.04	.21	.06	.14	.02	.10	.10
1974	.03	.16	.18	.13	.17	.10	.09	.09	---	.16	.16	.12	.13
1975	.19	.14	.15	.09	.10	.14	.10	.08	.08	.11	.15	.22	.13
1976	.26	.50	.22	.12	.13	.13	.09	.07	.09	.13	.12	.12	.17
1977	.23	.26	.20	.15	.18	---	.04	---	---	---	.13	.29	.19
1978	.14	.20	.27	.18	.27	.14	---	.19	.12	.15	.16	.18	.18
MEAN	.19	.23	.21	.12	.16	.10	.06	.11	.08	.12	.13	.21	.15

NOTE:

--- Indicates data missing or invalid.

TABLE 68

SULPHATION RATES ON THE LEAD PEROXIDE CANDLES AT
STATION 71013 (JAMES LYONS PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
(ALL VALUES IN MGM SO_3/100 CM^2/DAY)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	---	.06	.07	---	.18	.40	.18
1971	.25	.26	.26	.15	.15	.12	.08	.11	.08	.12	.14	.18	.16
1972	.18	.29	.13	.11	.15	.11	.04	.05	.06	.23	.13	.20	.14
1973	.13	.15	.16	---	.06	.08	.06	.27	.08	.11	.11	.10	.12
1974	N.D.	.12	21	.11	.15	.24	.08	.11	.10	.18	.14	.14	.13
1975	.20	.12	.13	---	---	.12	.14	.09	.09	.12	.12	.26	.14
1976	.22	.16	.20	.10	.09	.08	.08	.12	.09	.10	.13	.13	.13
1977	.17	.19	.23	.15	.17	---	.13	---	---	.21	.23	.37	.21
1978	.21	.14	.24	.16	.30	.12	.18	.16	.16	.22	.16	.18	.19
MEAN	.17	.18	.20	.13	.15	.12	.10	.12	.09	.16	.15	.22	.15

NOTE:

--- Indicates data missing or invalid.

N.D. : Below Detection Limit

TABLE 67

SULPHATION RATES ON THE LEAD PEROXIDE CANDLES AT
STATION 71014 (ALEXANDER HENRY HIGH SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
(ALL VALUES IN MGM SO_3/100 CM^2/DAY)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	.05	---	.09	.29	.31	.49	.25
1971	.25	.31	.31	.14	.15	.15	.05	.11	.19	.42	.27	.42	.23
1972	.40	.38	.20	.18	.25	.08	.04	.07	.24	.40	.22	.33	.23
1973	.30	.31	.32	---	.11	---	.05	.05	.20	.17	.05	.15	.17
1974	N.D.	.22	.30	.16	.22	.05	.08	.10	.12	.27	.32	.20	.17
1975	.27	.17	.12	.11	.14	.13	.10	---	---	.17	.12	.26	.16
1976	.33	.23	.13	.12	.10	.12	.10	.07	.10	.17	.17	.17	.15
1977	.19	.27	.26	.15	.15	---	.13	.57	.12	.21	.23	.57	.26
1978	.29	.18	.29	.18	.34	.18	.11	.14	.15	.26	.24	.33	.22
MEAN	.25	.26	.24	.15	.18	.12	.08	.16	.15	.26	.21	.32	.20

NOTE:

--- Indicates data missing or invalid.

N.D. : Below Detection Limit

TABLE 68

SULPHATION RATES ON THE LEAD PEROXIDE CANDLES AT
STATION 71015 (BAYVIEW PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
(ALL VALUES IN MGM SO_3/100 CM^2/DAY)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	.11	.14	.38	.77	.59	.44	.41
1971	.51	.44	.44	.29	.28	.22	.18	.26	.34	.46	.37	.41	.35
1972	.61	.52	.35	.24	.33	.19	.17	.16	.41	.35	.26	.35	.33
1973	.38	.41	.23	---	.34	.25	.15	.68	.34	.38	.34	.18	.33
1974	.09	.54	.44	.30	.30	.10	.13	.34	.24	.34	.34	.38	.30
1975	.38	.22	.34	.42	.23	.45	.32	.21	.34	.54	.58	.60	.39
1976	.44	.54	.52	.39	.32	.32	.25	.14	.17	.20	.18	.18	.30
1977	.20	.30	.31	.27	.30	---	.51	.16	.56	.98	.91	.72	.47
1978	.31	.18	.69	.68	.81	.57	.29	.77	.66	.67	.32	.49	.54
MEAN	.37	.39	.42	.37	.36	.30	.23	.32	.38	.52	.43	.42	.38

NOTE:

--- Indicates data missing or invalid.

TABLE 69

SULPHATION RATES ON THE LEAD PEROXIDE CANDLES AT
STATION 71016 (HOLY ANGELS SEPARATE SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
(ALL VALUES IN MGM SO_3/100 CM^2/DAY)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	.10	.08	.16	.29	.35	.42	.23
1971	.54	.35	.35	.24	.24	.14	.11	.09	.09	.21	.21	.36	.24
1972	.33	.43	.28	.17	.17	.05	.06	.08	.13	.29	.38	.40	.23
1973	.27	.29	---	---	.13	.10	.10	.38	.15	.24	.16	.18	.20
1974	N.D.	.27	.30	.17	.21	.11	.11	.14	.14	.24	.34	.23	.19
1975	.30	.28	.19	.18	.16	.16	.14	.09	.13	.23	.23	.29	.20
1976	.42	.26	.32	.17	.14	.14	.09	.10	.13	.27	.24	.24	.21
1977	.49	.39	.25	.15	.20	---	.20	.16	.17	.23	.34	.54	.28
1978	.44	.27	.34	.20	.37	.14	.18	.24	.20	.29	.26	.61	.30
MEAN	.35	.32	.29	.18	.20	.12	.12	.15	.14	.25	.28	.36	.23

NOTE:

--- Indicates data missing or invalid.
N.D. : Below Detection Limit

TABLE 70

SULPHATION RATES ON THE LEAD PEROXIDE CANDLES AT
STATION 71017 (OUR LADY OF LOURDES SEPARATE SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
(ALL VALUES IN MGM SO_3/100 CM^2/DAY)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	.05	.07	.08	.22	.26	.40	.18
1971	.24	.14	.14	.13	.13	.11	.07	.09	.08	.24	.15	.20	.14
1972	.22	.36	.18	.14	.17	.05	.07	.05	.08	.32	.17	.22	.17
1973	.18	.18	---	---	.09	.10	.07	.28	.04	.12	.11	.13	.13
1974	.03	.14	.23	.12	.15	.07	.09	.14	.10	.21	.19	.16	.14
1975	.25	.14	.14	.12	.11	.13	.12	.08	.09	.18	.12	.31	.15
1976	.31	.23	.24	.11	.08	.01	.08	.08	.10	.13	.13	.13	.14
1977	.19	.30	.25	.15	.17	---	---	.15	.12	.34	.31	.42	.24
1978	.29	.16	.34	.20	.29	.13	.08	.18	---	.26	---	.20	.21
MEAN	.21	.21	.22	.14	.15	.09	.08	.12	.09	.22	.18	.24	.16

NOTE:

--- Indicates data missing or invalid.

TABLE 71

SULPHATION RATES ON THE LEAD PEROXIDE CANDLES AT
STATION 71018 (FRANKLIN STREET PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
(ALL VALUES IN MGM $SO_3/100\ CM^2/DAY$)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	.09	.12	.13	.26	.27	.39	.21
1971	.36	.32	.32	.21	.22	.14	.17	.16	.13	.24	.22	.29	.23
1972	.29	.38	.22	.17	.21	.08	.10	.09	.10	.33	.23	.34	.21
1973	.23	.22	.15	---	.09	.11	---	.40	.09	.15	.17	.15	.18
1974	N.D.	.23	.26	.13	.15	.10	.11	.15	.13	.26	.19	N.D.	.14
1975	.48	.18	.14	.15	.13	.20	.23	.14	.16	.21	.22	.31	.21
1976	.34	.22	.30	.13	.14	.13	.11	.15	.14	.14	.14	.14	.17
1977	.23	.30	.29	.17	.25	---	.19	.27	---	.37	.47	.48	.30
1978	.40	.27	.47	.22	.40	.24	.37	1.60	.14	.39	.28	.43	.43
MEAN	.29	.27	.27	.17	.20	.14	.17	.34	.13	.26	.24	.28	.23

NOTE:

--- Indicates data missing or invalid.

N.D. Below Detection Limit

TABLE 72

SULPHATION RATES ON THE LEAD PEROXIDE CANDLES AT
STATION 71019 (S. F. HOWE PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1970 TO 1978
(ALL VALUES IN MGM SO_3/100 CM^2/DAY)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1970	---	---	---	---	---	---	.09	.05	---	.23	.32	.44	.23
1971	.43	.36	.36	.13	.13	.18	.10	.11	.12	.21	.27	.35	.23
1972	.33	.39	.22	.18	.18	.08	.06	.05	.12	.41	.29	.42	.23
1973	.26	.30	---	---	.08	.06	---	.31	.12	.15	.10	.28	.18
1974	N.D.	.23	.24	.13	.16	.10	.10	.11	.11	.25	.31	.22	.16
1975	.39	.22	.17	.14	.11	.13	.10	.07	.12	.20	.09	.17	.16
1976	.35	.21	.29	.17	.10	.14	.12	.10	.10	.23	.22	.22	.19
1977	.25	.25	.25	.17	.25	---	.19	.16	.12	.21	.40	.82	.28
1978	.44	.27	.34	.27	.34	.14	.11	.15	.16	.34	.49	.73	.32
MEAN	.31	.28	.27	.17	.17	.12	.11	.12	.12	.25	.28	.41	.22

NOTE:

--- Indicates data missing or invalid.

N.D. : Below Detection Limit

TABLE 73

SULPHATION RATES ON THE LEAD PEROXIDE CANDLES AT
STATION 71022 (SOO COLLEGE) IN SAULT STE. MARIE FROM 1976 TO 1978
(ALL VALUES IN MGM $SO_3/100\ CM^2/DAY$)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1976	---	---	---	---	---	---	---	---	---	.38	---	---	.38
1977	.55	.41	.28	.16	.20	---	.27	.33	.03	.32	.62	.73	.35
1978	.52	.31	.52	.45	.30	.25	.25	.51	.31	.55	.45	1.10	.46
MEAN	.54	.36	.40	.31	.25	.26	.26	.42	.17	.42	.54	.92	.41

NOTE:

--- Indicates data missing or invalid.

TABLE 74

SULPHATION RATES ON THE LEAD PEROXIDE CANDLES AT
STATION 71049 (LAND REGISTRY OFFICE) IN SAULT STE. MARIE FROM 1975 TO 1978
(ALL VALUES IN MGM SO_3/100 CM^2/DAY)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1975	---	---	---	---	---	---	---	.12	.11	.25	.22	.27	.19
1976	.34	.25	.09	.17	.13	.14	.14	.12	.11	.23	.23	.23	.18
1977	.23	.27	.23	.16	.23	---	.26	.12	.19	.26	.19	.42	.23
1978	.37	.27	.30	.32	.28	.20	.16	---	.21	.28	.26	---	.27
MEAN	.31	.26	.21	.22	.21	.17	.19	.12	.16	.26	.23	.31	.22

NOTE:

--- Indicates data missing or invalid.

TABLE 75

SUMMARY OF SULPHATION RATE DATA
COLLECTED IN SAULT STE. MARIE FROM 1970 TO 1978.*

Location	Period	No. of Samples	Mean Sulphation Rate	Max. Value	No. of Samples Above Provincial Criteria**
Beaver Hotel	1970-1976	75	0.30	0.72	2
Soo College	1976-1978	24	0.41	1.10	2
Bayview Public School	1970-1978	100	0.38	0.98	5
Franklin St. Public School	1970-1978	98	0.23	1.60	1
S.F. Howe Public School	1970-1978	97	0.22	0.82	2
Lady of Lourdes Separate School	1970-1978	96	0.16	0.42	Nil
Holy Angels Separate School	1970-1978	99	0.23	0.61	Nil
James Lyons Public School	1970-1978	94	0.15	0.40	Nil
Land Registry Office	1975-1978	38	0.22	0.42	Nil
Alexander Henry High School	1970-1978	96	0.20	0.57	Nil
Anna McRae Public School	1970-1978	95	0.15	0.43	Nil
	Total	912		Total	12

*All values are in mg SO_3/100 cm^2/day

**Provincial Criteria: 0.70mg SO_3/100 cm^2/day

TABLE 76

FLUORIDATION RATES ON LIME CANDLES AT
STATION 71010 (BEAVER HOTEL) IN SAULT STE. MARIE FROM 1971 TO 1976
(ALL VALUES IN MICROGRAMS F/100 CM^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1971	---	---	---	---	---	---	---	19	25	---	30	170	61
1972	110	16	35	N.D.	25	17	27	15	24	17	70	27	32
1973	20	26	12	---	15	47	---	31	32	38	10	---	26
1974	15	34	19	23	30	17	19	16	21	26	11	18	21
1975	8	14	22	32	16	17	41	61	43	37	40	41	31
1976	10	13	5	23	29	16	46	14	23	42	19	19	22
MEAN	33	21	19	20	23	23	33	26	28	32	30	55	28

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the M.O.E. criterion: 40 ug F/100 cm^2/30d (April 15 to October 15)
80 ug F/100 cm^2/30d (October 16 to April 14)

TABLE 77

FLUORIDATION RATES ON LIME CANDLES AT
STATION 71015 (BAYVIEW PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1971 TO 1978
(ALL VALUES IN MICROGRAMS F/100 CM^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1971	---	---	---	---	---	---	---	---	16	---	33	100	50
1972	100	25	35	7	22	22	18	20	23	40	9	37	30
1973	29	27	12	---	41	50	---	100	32	27	35	---	39
1974	20	34	16	25	6	34	12	27	17	31	34	18	23
1975	12	4	29	41	18	42	28	80	40	37	46	40	35
1976	N.D.	54	17	17	29	34	20	8	12	11	3	3	17
1977	19	16	15	32	20	11	26	25	28	35	49	26	25
1978	11	10	31	44	---	26	51	79	46	25	15	23	33
MEAN	27	24	22	28	23	31	26	36	27	29	28	35	28

NOTE:

--- Indicates data missing or invalid.
N.D. Below Detection Limit
Underlined values exceed the M.O.E. criterion: 40 ug F/100 cm^2/30d (April 15 to October 15)
80 ug F/100 cm^2/30d (October 16 to April 14)

TABLE 78

FLUORIDATION RATES ON LIME CANDLES AT
STATION 71017 (OUR LADY OF LOURDES SEPARATE SCHOOL) IN SAULT STE. MARIE FROM 1971 TO 1978
(ALL VALUES MICROGRAMS F/100 CM^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1971	---	---	---	---	---	---	---	13	12	---	18	32	19
1972	33	14	22	6	17	17	13	7	15	25	12	17	17
1973	29	17	15	---	11	10	--	44	13	15	4	---	18
1974	18	22	13	10	24	52	16	5	7	16	6	9	17
1975	---	16	9	8	5	8	11	60	19	10	10	9	15
1976	N.D.	N.D.	3	8	N.D.	6	55	4	4	2	N.D.	N.D.	7
1977	8	1	1	8	3	4	7	8	4	9	7	8	6
1978	7	9	10	17	---	13	11	16	14	11	7	16	12
MEAN	16	11	10	10	10	16	19	20	11	13	8	13	13

NOTE:

--- Indicates data missing or invalid.
N.D. Below Detection limit.

TABLE 79

FLUORIDATION RATES ON LIME CANDLES AT
STATION 71018 (FRANKLIN STREET PUBLIC SCHOOL) IN SAULT STE. MARIE FROM 1971 TO 1978
(ALL VALUES IN MICROGRAMS F/100 CM^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1971	---	---	---	---	---	---	---	16	14	---	18	20	17
1972	15	16	22	4	17	22	20	20	12	11	30	25	17
1973	12	24	9	---	15	21	---	50	13	15	4	---	18
1974	15	25	21	8	9	11	19	8	24	16	6	9	14
1975	8	10	9	---	---	---	30	49	27	12	---	10	19
1976	N.D.	6	6	10	1	6	14	8	10	4	N.D.	N.D.	5
1977	6	8	6	11	10	4	11	10	11	17	15	11	10
1978	9	10	14	18	---	13	13	14	13	15	10	17	13
MEAN	8	14	11	12	9	11	18	19	16	13	14	15	13

NOTE:

--- Indicates data missing or invalid.
N.D. Below Detection Limit
Underlined values exceed M.O.E. criterion: 40 ug F/100 cm^2/30d (April 15 to October 15)
80 ug F/100 cm^2/30d (October 16 to April 14)

TABLE 80

FLUORIDATION RATES ON LIME CANDLES AT
STATION 71022 (SAULT COLLEGE, QUEENS ST.) SAULT STE. MARIE IN 1977 and 1978
(ALL VALUES IN MICROGRAMS F/100 CM^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1977	5	50	23	23	28	41	24	22	22	21	21	28	26
1978	23	29	40	19	---	18	13	44	39	31	26	56	31
MEAN	14	40	32	21	28	30	19	33	31	26	24	42	28

NOTE:

--- Indicates data missing or invalid.
Underlined values exceed the M.O.E. criterion: 40 ug F/100 cm^2/30d (April 15 to October 15)
80 ug F/100 cm^2/30d (October 16 to April 14)

TABLE 81

FLUORIDATION RATES ON LIME CANDLES AT
STATION 71049 (LAND REGISTRY OFFICE) IN SAULT STE. MARIE FROM 1975 TO 1978
(ALL VALUES IN MICROGRAMS F/100 CM^2/30 DAYS)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mean
1975	---	---	---	---	---	---	---	38	26	18	17	18	23
1976	6	8	11	11	1	6	14	4	9	8	N.D.	N.D.	7
1977	6	11	11	8	9	10	11	10	8	13	8	13	10
1978	11	14	16	17	---	13	16	26	23	17	13	13	14
MEAN	8	11	13	12	5	10	17	17	16	14	12	14	11

NOTE:

--- Indicates data missing or invalid.
N.D. Below Detection Limit.

TABLE 82

SUMMARY OF FLUORIDATION RATE DATA
COLLECTED IN SAULT STE. MARIE FROM 1971 TO 1978.*

Location	Period	No. of Samples	Mean Fluoridation Rate	Max. Value	No. of Samples Above Provincial Criteria**
Beaver Hotel	1971-1976	61	28	170	7
Soo College	1977-1978	23	28	56	2
Bayview Public School	1971-1978	83	28	100	12
Franklin St. Public School	1971-1978	80	13	50	2
Our Lady of Lourdes Public School	1971-1978	83	13	60	4
Land Registry Office	1975-1978	40	11	38	Nil
	Total	370			Total 27

*All values in ug F/100 cm^2/30 d
**Provincial Criteria: 40 ug F/100 cm^2/30 d (April 15 to October 15)
80 ug F/100 cm^2/30 d (October 16 to April 14)

TABLE 83

CONCENTRATIONS OF VARIOUS CHEMICAL ELEMENTS IN MANITOBA MAPLE FOLIAGE SAMPLES COLLECTED IN THE VICINITY OF ALGOMA STEEL CORPORATION AT SAULT STE. MARIE IN 1976 AND 1977.

Site	Location	Year	S	Fe	As	Mn	F	Zn
1	625m NW of Algoma Steel	1976	0.27	1020	1.3	122	52	40
		1977	0.27	1443	1.3	157	39	29
2	1250m WNW	1977	0.35	1153	0.8	103	21	23
4	1200m NW	1976	0.22	1913	1.3	210	42	60
		1977	0.30	1620	0.9	158	43	43
5	1875m NW	1976	0.22	757	0.7	97	14	40
		1977	0.28	863	0.5	66	8	24
6	1025m N	1976	0.20	847	0.6	110	12	45
		1977	0.31	1150	0.5	105	13	35
7	1700m N	1976	0.22	727	0.6	86	11	37
		1977	0.33	934	0.4	88	12	30
8	2400m N	1976	0.17	413	0.4	43	4	26
		1977	0.26	360	0.3	46	4	19
9	1175m NNE	1977	0.29	1396	0.9	189	25	41
10	1750m NNE	1977	0.29	963	0.4	83	15	32
11	1525m NE	1977	0.17	727	0.4	77	10	30
12	1975m NE	1976	0.17	700	0.6	54	8	40
		1977	0.27	867	0.4	67	10	32
13	2325m NE	1976	0.16	627	0.5	68	8	39
		1977	0.32	743	0.3	70	9	36

TABLE 83 continued

CONCENTRATIONS OF VARIOUS CHEMICAL ELEMENTS IN MANITOBA MAPLE FOLIAGE
SAMPLES COLLECTED IN THE VICINITY OF ALGOMA STEEL CORPORATION AT SAULT STE. MARIE IN 1976 AND 1977.

Site	Location	Year	S	Fe	As	Mn	F	Zn
14	775m E	1976	0.18	1767	2.4	260	66	69
		1977	0.25	1187	1.6	134	60	48
15	1625m ENE	1977	0.38	823	0.5	62	11	42
16	2250m ENE	1976	0.20	587	0.6	52	9	33
		1977	0.27	723	0.3	37	7	30
17	1450m ESE	1976	0.16	957	1.0	107	26	41
		1977	0.27	823	0.8	121	21	38
18	2150m ESE	1976	0.19	853	1.0	70	15	47
		1977	0.27	603	0.4	46	16	31
19	875m SSE	1976	0.29	2900	5.2	133	207	136
		1977	0.45	1550	3.9	86	128	50
20	1450m Se	1977	0.47	1273	1.2	132	46	31
Control	8675m E	1976	0.19	250	0.3	37	3	38

TABLE 84

CONCENTRATIONS OF VARIOUS CHEMICAL ELEMENTS IN SOIL (0-10cm)
SAMPLES COLLECTED IN THE VICINITY OF ALGOMA STEEL CORPORATION AT SAULT STE. MARIE IN 1976 AND 1977.

Site	Location	Year	S	Fe	As	Mn	Zn	Ca	Mg
1	625m NW of Algoma Steel	1976	0.10	1.72	16.8	537	223	0.21	0.30
		1977	0.12	1.23	13.9	509	160	0.22	0.17
2	1250m WNW	1977	0.05	0.55	1.8	141	44	0.09	0.11
3	2375m W	1977	0.19	3.98	31.7	2033	562	0.34	0.31
4	1200m NW	1976	0.03	0.88	3.3	313	47	0.42	0.47
		1977	0.06	0.94	3.6	355	61	0.23	0.12
5	1875m NW	1976	0.02	0.86	4.3	143	35	0.10	0.25
		1977	0.05	0.83	7.1	190	49	0.06	0.16
6	1025m N	1976	0.04	0.78	4.2	303	130	0.28	0.29
		1977	0.06	0.74	3.3	288	80	---	---
7	1700m N	1976	0.04	0.66	2.3	217	63	0.19	0.19
		1977	0.06	0.88	2.8	288	73	0.21	0.19
8	2400m N	1976	0.06	1.08	2.4	840	49	0.13	0.53
		1977	0.04	1.01	2.3	205	50	0.13	0.21
9	1175m NNE	1977	0.14	0.99	7.7	646	188	0.24	0.18
10	1750m NNE	1977	0.03	0.97	2.2	528	56	0.29	0.30
11	1525m NE	1977	0.19	3.57	30.1	117	540	0.16	0.21
12	1975m NE	1976	0.04	1.23	6.1	353	120	0.28	0.35
		1977	0.06	0.91	3.1	301	102	0.16	0.21
13	2325m NE	1976	0.03	0.69	6.9	173	45	0.12	0.16
		1977	0.04	0.64	3.1	293	56	0.40	0.38

TABLE 84 continued

CONCENTRATIONS OF VARIOUS CHEMICAL ELEMENTS IN SOIL (0-10cm)
SAMPLES COLLECTED IN THE VICINITY OF ALGOMA STEEL CORPORATION AT SAULT STE. MARIE IN 1976 AND 1977.

Site	Location	Year	S	Fe	As	Mn	Zn	Ca	Mg
14	775m E	1976	0.09	0.96	9.9	307	203	0.21	0.15
		1977	0.04	0.51	4.6	288	116	0.20	0.09
15	1625m ENE	1977	0.12	1.34	8.3	511	307	0.26	0.20
16	2250m ENE	1976	0.09	1.27	6.8	420	137	0.26	0.25
		1977	0.06	1.01	3.5	327	248	0.17	0.17
17	1450m ESE	1976	0.04	0.84	6.7	437	160	0.28	0.22
		1977	0.09	1.25	5.9	675	310	0.44	0.28
18	2150m ESE	1976	0.09	1.78	7.6	2033	160	0.88	0.64
		1977	0.09	0.80	3.6	488	107	0.72	0.38
19	875m SSE	1976	0.06	2.00	16.4	520	163	0.15	0.21
		1977	0.07	1.35	11.2	461	180	0.24	0.20
20	1450m SE	1977	0.19	1.60	12.7	384	133	0.17	0.13
Control	8675m E	1976	0.02	0.17	0.9	28	14	0.01	0.02

TABLE 85

CONDITION AND DEPTH OF SNOW AT SAMPLING SITES
IN THE VICINITY OF ALGOMA STEEL CORPORATION AT SAULT STE. MARIE, JANUARY 26 AND 27, 1977.

Site	Location	Total Depth (cm)	No. of Crust Layers	Banding in Profile	Melt-Water Precipitate
1	1170m W	81	0	10	very heavy
2	2000m W	56	0	9	moderate
3	3610m W	79	0	5	moderate
4	5870m W	67	0	none	very light
5	740m NW	89	0	11	very heavy
6	1390m NW	52	0	6	moderate
7	1910m NW	53	0	4 faint	moderate
8	2910m NW	59	0	none	moderate
9	1260m N	57	1	4 light	moderate
10	1780m N	51	1	4 light	light
11	2560m N	59	0	2 light	moderate
12	4910m N	61	1	none	light
13	1700m NE	57	1	3	light
14	2300m NE	62	1	4	very light
15	2870m NNE	61	1	4 very light	light
16	4220m NE	83	1	none	----------
17	910m E	38	0	7	heavy
18	2040m ENE	48	0	6 faint	light
19	2650m ENE	61	0	7 very faint	light mod.
20	5220m ENE	95	0	1 very faint	light

TABLE 85 continued

CONDITION AND DEPTH OF SNOW AT SAMPLING SITES
IN THE VICINITY OF ALGOMA STEEL CORPORATION AT SAULT STE. MARIE, JANUARY 26 AND 27, 1977.

Site	Location	Total Depth (cm)	No. of Crust Layers	Banding in Profile	Melt-Water Precipitate
21	870m ESE	99	0	5	heavy
22	1520m ESE	44	0	4 light	very light
23	2220m ESE	59	0	5 very light	light
24	3260m SE	23	0	none	light
25	1040m SSE	39	0	4	heavy
26	1560m SE	50	0	1	light
27	2130m SE	28	0	1 light	moderate
28	CONTROL 1	37	0	none	----------
29	CONTROL 2	78	0	none	----------

TABLE 86

CONCENTRATIONS OF VARIOUS CHEMICAL ELEMENTS AND OTHER PARAMETERS IN NON-ACIDIFIED SNOW SAMPLES COLLECTED IN SAULT STE. MARIE IN JANUARY 1977.*

Site	Location	Sodium	Potassium	Calcium	Magnesium	Sulphate	Arsenic	Suspended Solids	Alkalinity	pH
1	1170m W	0.58	0.44	12.00	1.78	6.2	0.025	314	40.5	9.8
2	2000m W	0.81	0.36	9.70	1.05	4.7	0.010	71	27.5	9.5
3	3610m W	1.43	0.19	7.80	0.85	3.1	0.009	44	20.0	9.7
4	5870m W	1.25	0.11	2.68	0.36	2.0	0.003	12	7.5	7.8
5	740m NW	1.87	0.58	11.90	2.13	8.4	0.025	760	37.5	9.6
6	1390m NW	3.35	0.23	5.80	0.84	3.9	0.008	50	18.0	8.3
7	1910m NW	0.90	0.18	4.30	0.63	2.7	0.005	41	14.5	9.0
8	2910m NW	1.17	0.33	3.90	0.47	2.3	0.006	25	7.5	8.1
9	1260m N	0.59	0.15	3.78	0.57	2.9	0.006	33	9.5	7.5
10	1780m N	1.87	0.15	3.55	0.55	3.3	0.005	37	10.0	6.4
11	2560m N	1.15	0.20	2.23	0.36	2.4	0.004	33	6.5	8.4
12	4910m N	0.88	0.19	2.20	0.31	2.3	0.002	13	5.5	6.1
13	1700m NE	1.06	0.47	4.05	0.56	3.1	0.005	50	9.5	8.7
14	2300m NE	1.03	0.19	3.13	0.40	2.9	0.004	21	8.0	6.6
15	2870m NNE	0.73	0.22	2.63	0.38	2.3	0.003	23	7.5	6.7
16	4220m NE	0.91	0.15	1.58	0.27	1.7	0.002	13	5.0	7.8
17	910m E	1.35	0.29	7.50	1.90	8.3	0.020	190	17.5	8.8
18	2040m ENE	1.18	0.17	3.63	0.70	3.9	0.008	49	10.0	6.4
19	2650m ENE	0.75	0.19	2.63	0.52	2.9	0.005	35	7.0	7.9
20	5220m ENE	1.39	0.10	1.33	0.27	1.9	0.003	7	3.5	5.7
21	870m ESE	1.50	0.32	8.40	1.45	6.7	0.020	120	20.5	9.0
22	1520m ESE	0.75	0.20	5.30	1.04	4.2	0.008	66	14.0	6.3

TABLE 86 continued

CONCENTRATIONS OF VARIOUS CHEMICAL ELEMENTS AND OTHER PARAMETERS IN NON-ACIDIFIED SNOW SAMPLES COLLECTED IN SAULT STE. MARIE IN JANUARY 1977.*

Site	Location	Sodium	Potassium	Calcium	Magnesium	Sulphate	Arsenic	Suspended Solids	Alkalinity	pH
23	2220m ESE	0.90	0.22	3.35	0.50	4.1	0.004	30	10.5	7.7
24	3260m SE	2.08	0.12	1.68	0.28	2.9	0.003	13	5.5	6.5
25	1040m SSE	0.82	0.31	7.60	1.70	7.9	0.025	246	18.5	8.8
26	1560m SE	1.05	0.20	4.80	0.76	5.0	0.007	49	11.0	6.8
27	2130m SE	1.09	0.15	3.63	0.60	4.0	0.003	45	9.5	8.7
28	CONTROL 1	2.20	0.06	0.53	0.08	1.2	0.001	8	1.0	6.3
29	CONTROL 2	1.15	0.17	0.75	0.15	1.5	0.001	11	2.5	5.1

*All values represent the means of duplicate samples and are reported as mg/l except for pH.

TABLE 87

CONCENTRATIONS OF VARIOUS CHEMICAL ELEMENTS IN ACIDIFIED SNOW SAMPLES COLLECTED IN SAULT STE. MARIE IN JANUARY, 1977.*

Site	Location	Iron	Manganese	Lead	Aluminum	Copper	Zinc
1	1170m W	7.75	1.80	0.070	1.30	0.019	0.330
2	2000m W	6.20	1.80	0.057	1.37	0.009	0.300
3	3610m W	2.60	0.73	0.017	0.63	0.002	0.066
4	5870m W	0.62	0.13	0.009	0.16	0.001	0.018
5	740m NW	4.27	0.97	0.035	2.45	0.013	0.154
6	1390m NW	3.00	0.40	0.032	0.76	0.005	0.072
7	1910m NW	0.78	0.24	0.017	0.31	0.003	0.039
8	2910m NW	1.80	0.40	0.017	0.37	0.002	0.033
9	1260m N	1.60	0.33	0.035	0.47	0.004	0.059
10	1780m N	1.40	0.26	0.051	0.47	0.005	0.056
11	2560m N	1.10	0.20	0.027	0.36	0.003	0.047
12	4910m N	0.80	0.13	0.015	0.25	0.002	0.035
13	1700m NE	1.85	0.36	0.042	0.43	0.004	0.075
14	2300m NE	1.35	0.28	0.045	0.42	0.004	0.066
15	2870m NNE	0.61	0.12	0.025	0.25	0.001	0.042
16	4220m NE	0.53	0.09	0.017	0.16	0.001	0.034
17	910m E	10.30	0.69	0.081	1.05	0.011	0.088
18	2040m ENE	2.60	0.21	0.061	0.42	0.006	0.075
19	2650m ENE	1.35	0.18	0.034	0.35	0.002	0.097
20	5220m ENE	0.67	0.08	0.043	0.25	0.003	0.039
21	870m ESE	11.20	1.75	0.101	1.40	0.031	0.310
22	1520m ESE	3.25	0.36	0.037	0.70	0.009	0.087

TABLE 87 continued

CONCENTRATIONS OF VARIOUS CHEMICAL ELEMENTS IN ACIDIFIED SNOW SAMPLES COLLECTED IN SAULT STE. MARIE IN JANUARY, 1977.*

Site	Location	Iron	Manganese	Lead	Aluminum	Copper	Zinc
23	2220m ESE	1.35	0.19	0.029	0.45	0.003	0.075
24	3260m SE	0.48	0.06	0.033	0.23	0.006	0.050
25	1040m SSE	4.65	0.51	0.047	0.74	0.013	0.180
26	1560m SE	3.30	0.48	0.043	0.79	0.008	0.108
27	2130m SE	1.55	0.26	0.390	0.49	0.004	0.660
28	CONTROL 1	0.23	0.01	0.022	0.20	0.002	0.021
29	CONTROL 2	0.18	0.02	0.015	0.16	0.002	0.017

*All values represent the means of duplicate samples and are reported as mg/l

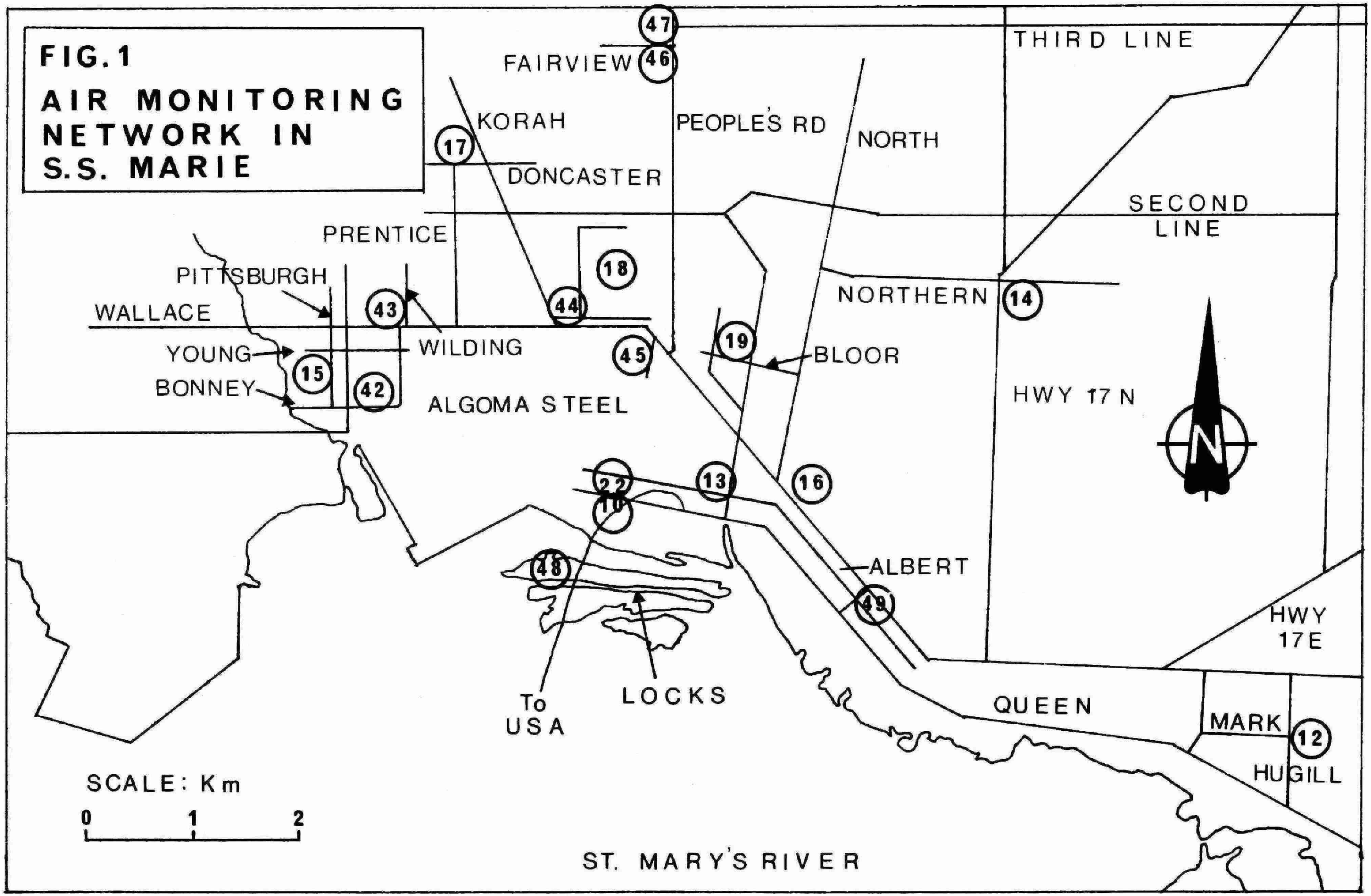


FIG. 1
AIR MONITORING NETWORK IN S.S. MARIE
47
46
FAIRVIEW
THIRD LINE
KORAH
PEOPLE'S RD
NORTH
17
DONCASTER
SECOND LINE
PRENTICE
18
PITTSBURGH
NORTHERN
14
WALLACE
43
44
WILDING
YOUNG
19
45
BLOOR
15
BONNEY
42
ALGOMA STEEL
HWY 17 N
N
22
13
16
10
ALBERT
48
49
HWY 17E
To USA
LOCKS
QUEEN
MARK
12
HUGILL
SCALE: Km
0
1
2
ST. MARY'S RIVER

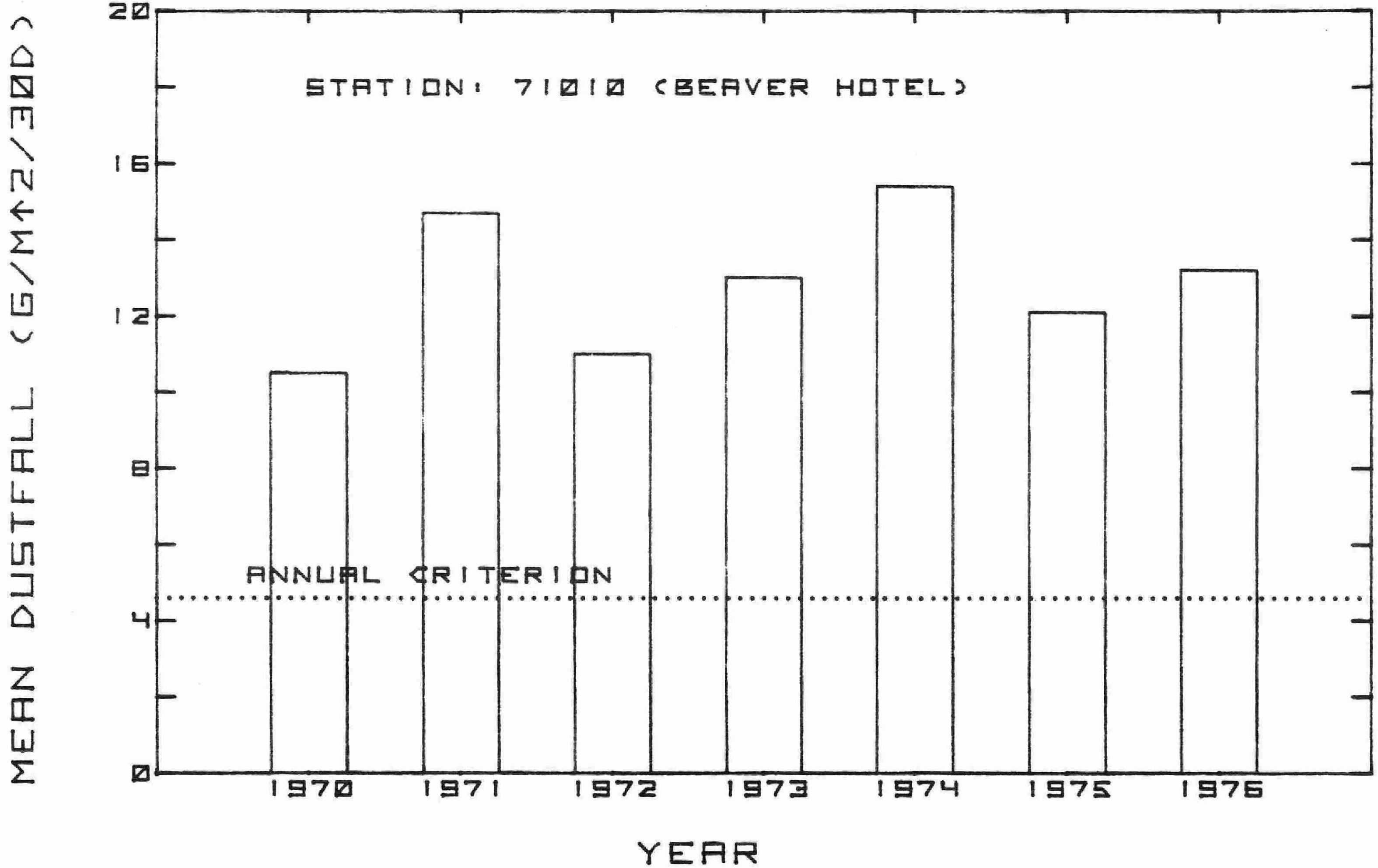


FIG. 2 ANNUAL MEAN DUSTFALL LEVELS

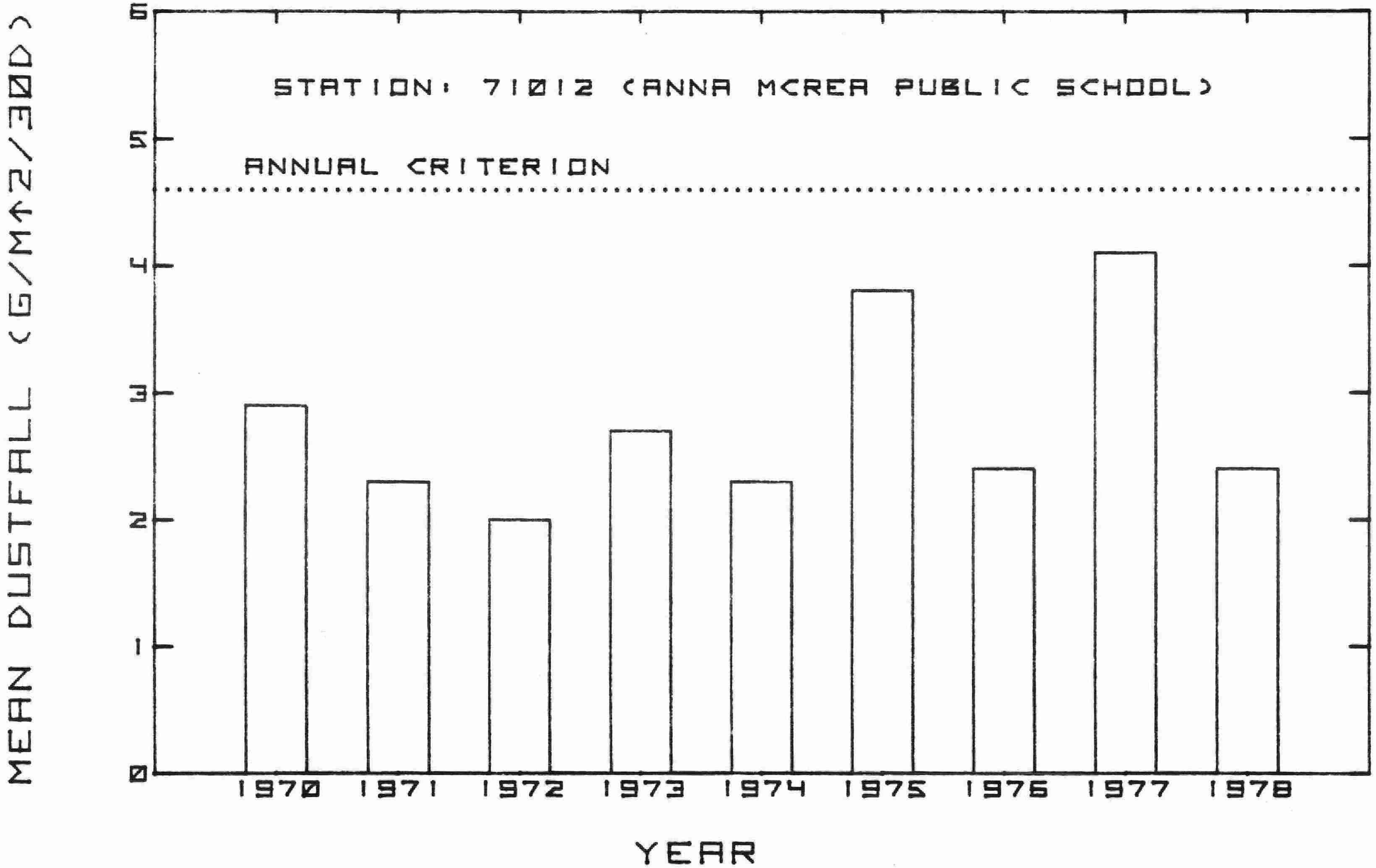


FIG. 3 ANNUAL MEAN DUSTFALL LEVELS

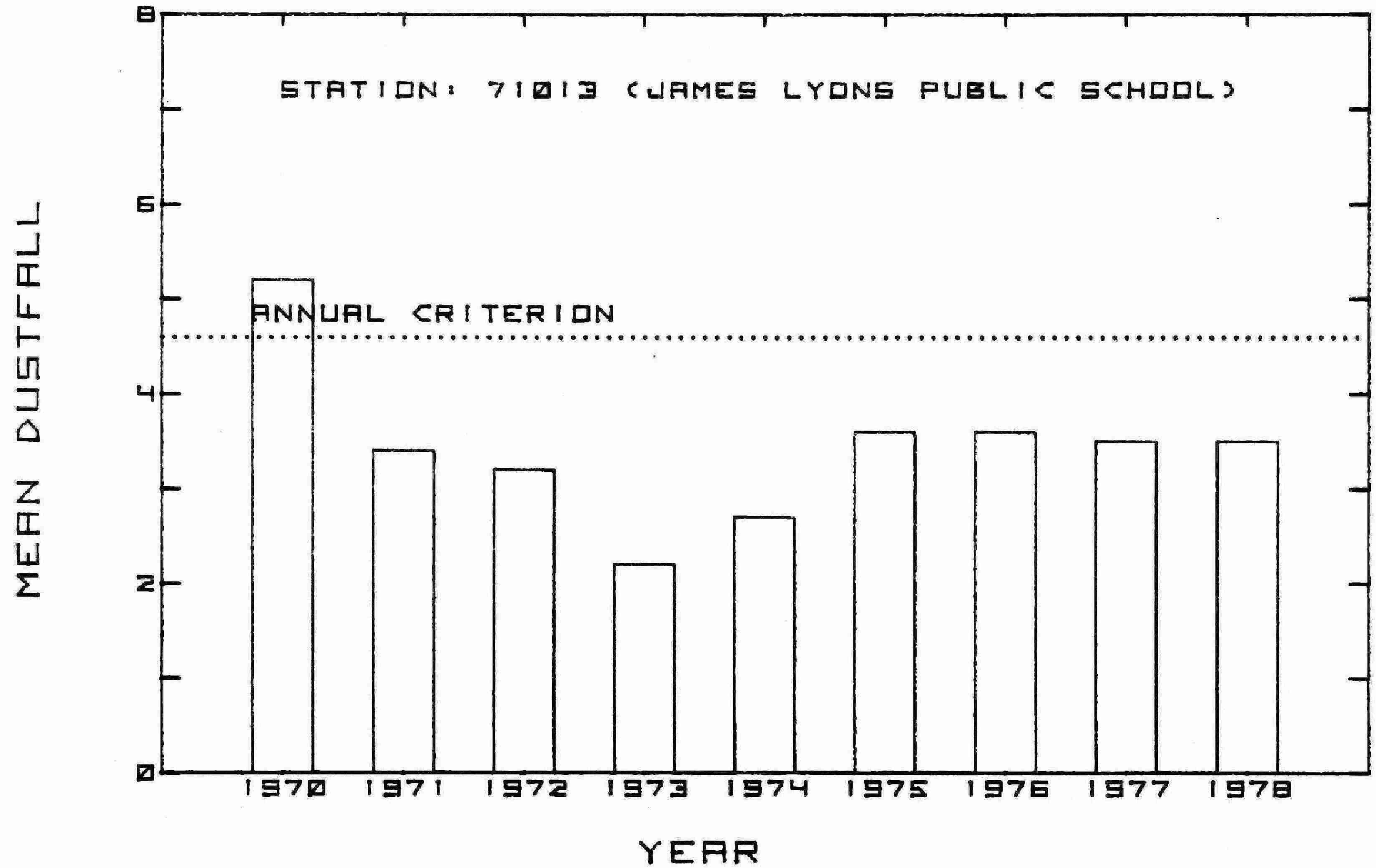


FIG. 4 ANNUAL MEAN DUSTFALL LEVELS

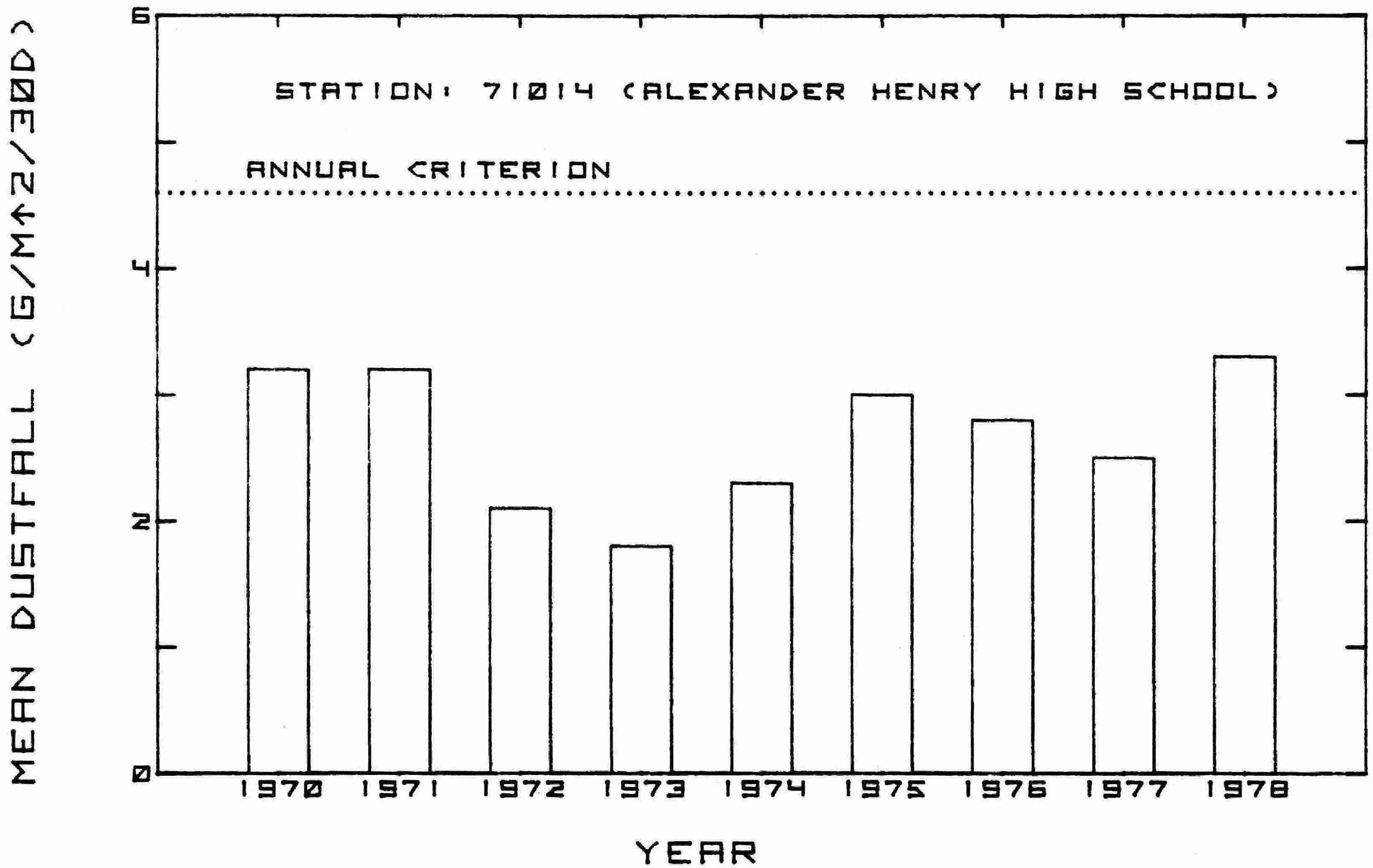


FIG. 5 ANNUAL MEAN DUSTFALL LEVELS

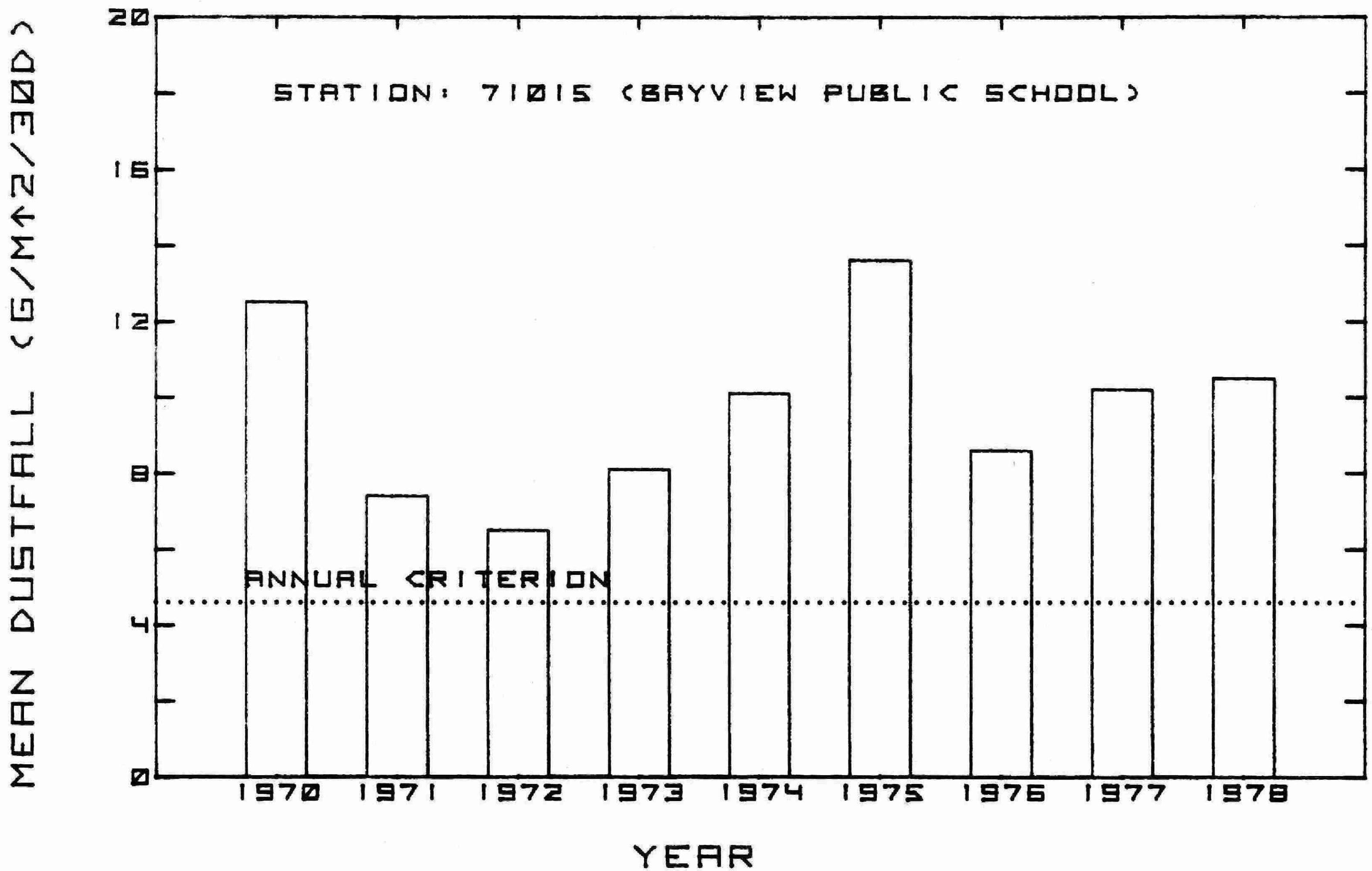


FIG. 6 ANNUAL MEAN DUSTFALL LEVELS

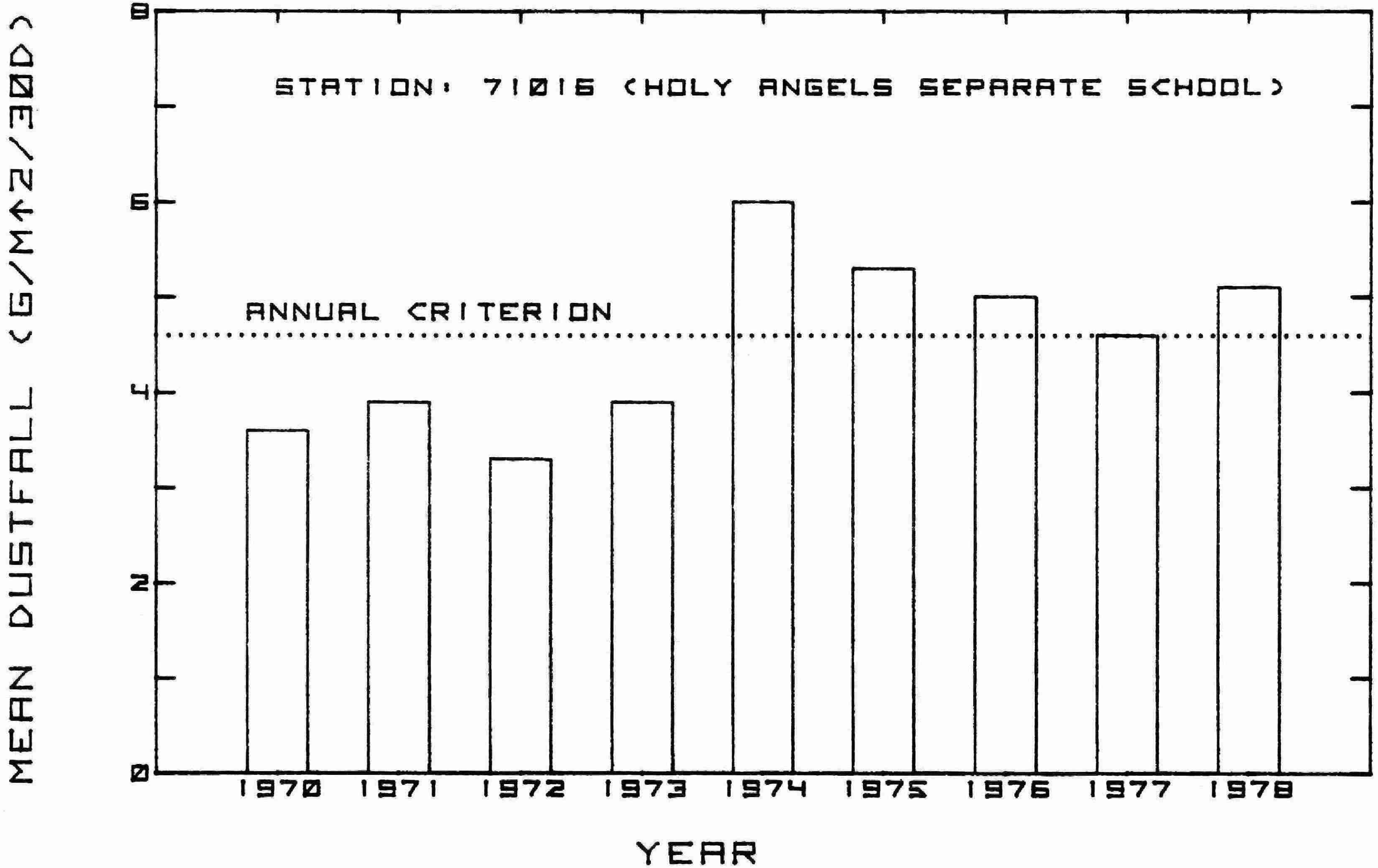


FIG. 7 ANNUAL MEAN DUSTFALL LEVELS

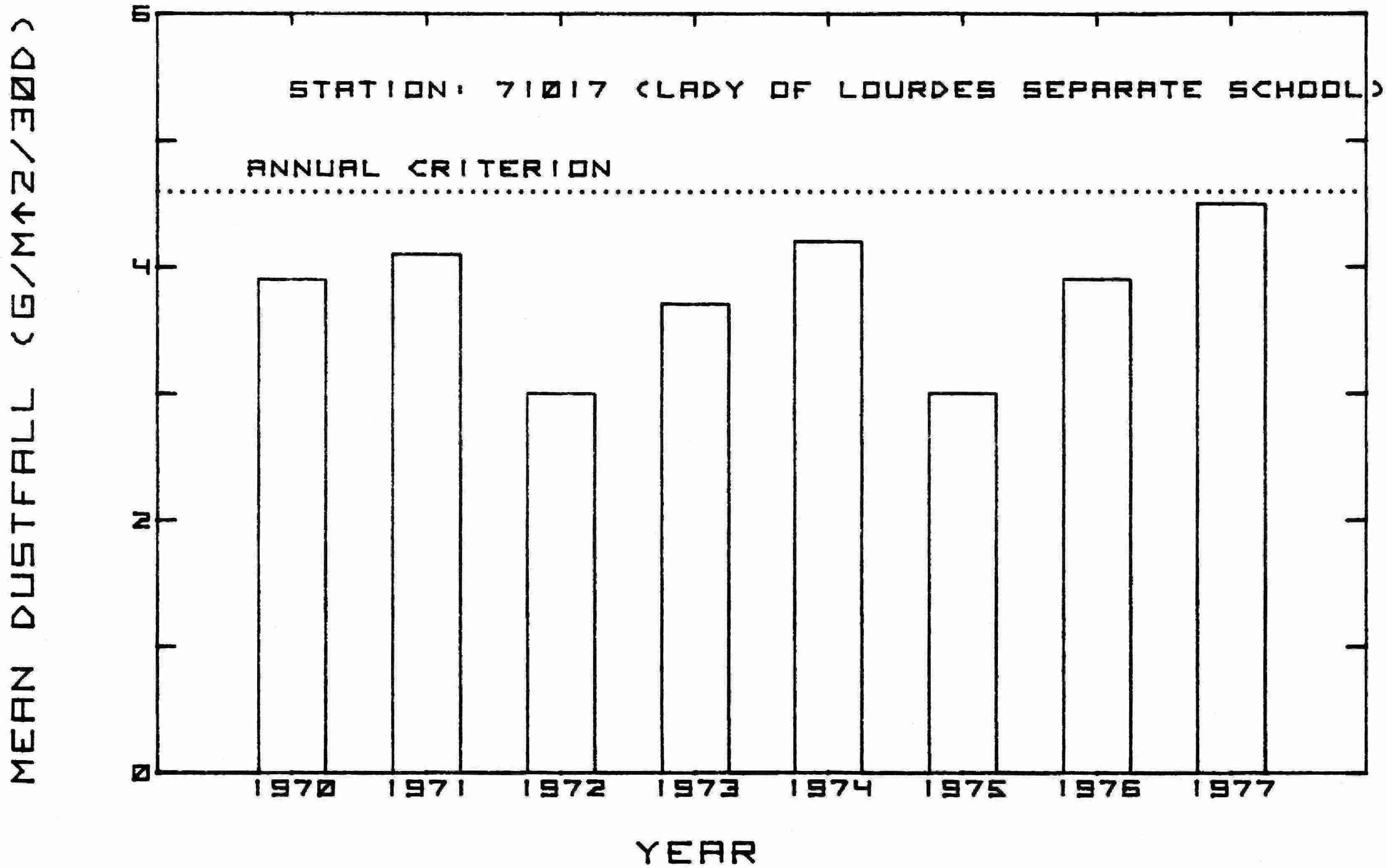


FIG. 8 ANNUAL MEAN DUSTFALL LEVELS

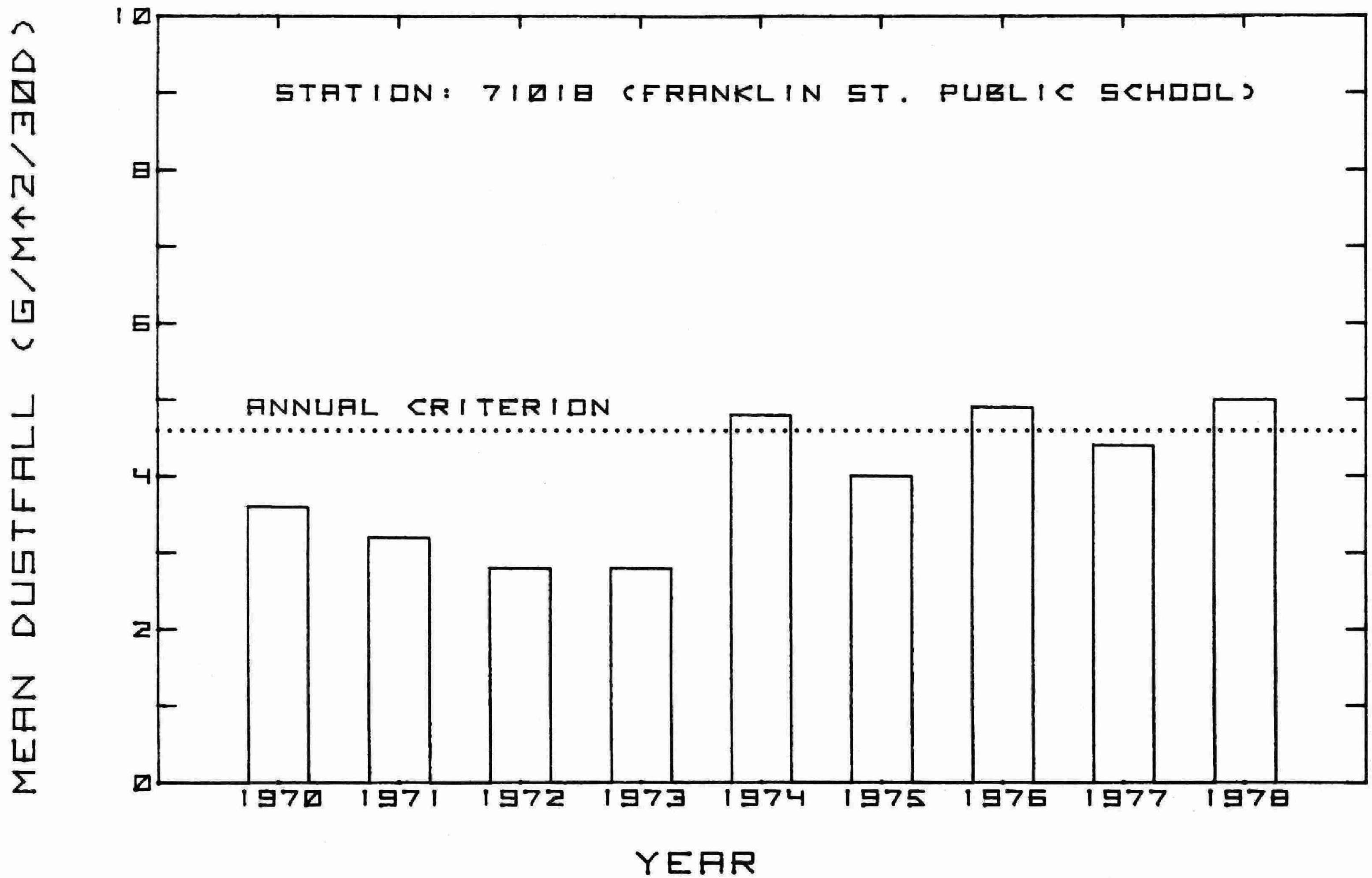


FIG. 9 ANNUAL MEAN DUSTFALL LEVELS

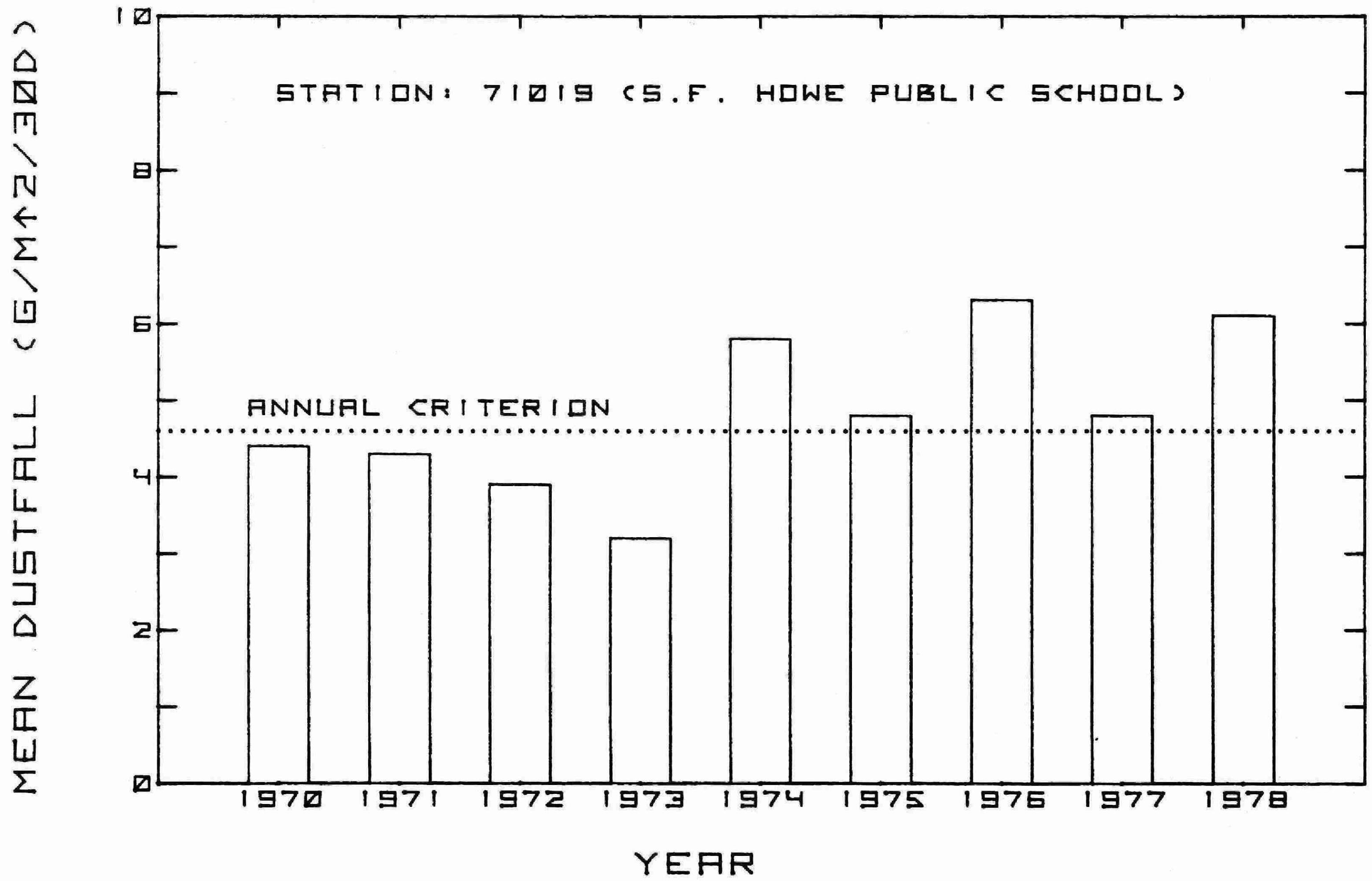


FIG. 10 ANNUAL MEAN DUSTFALL LEVELS

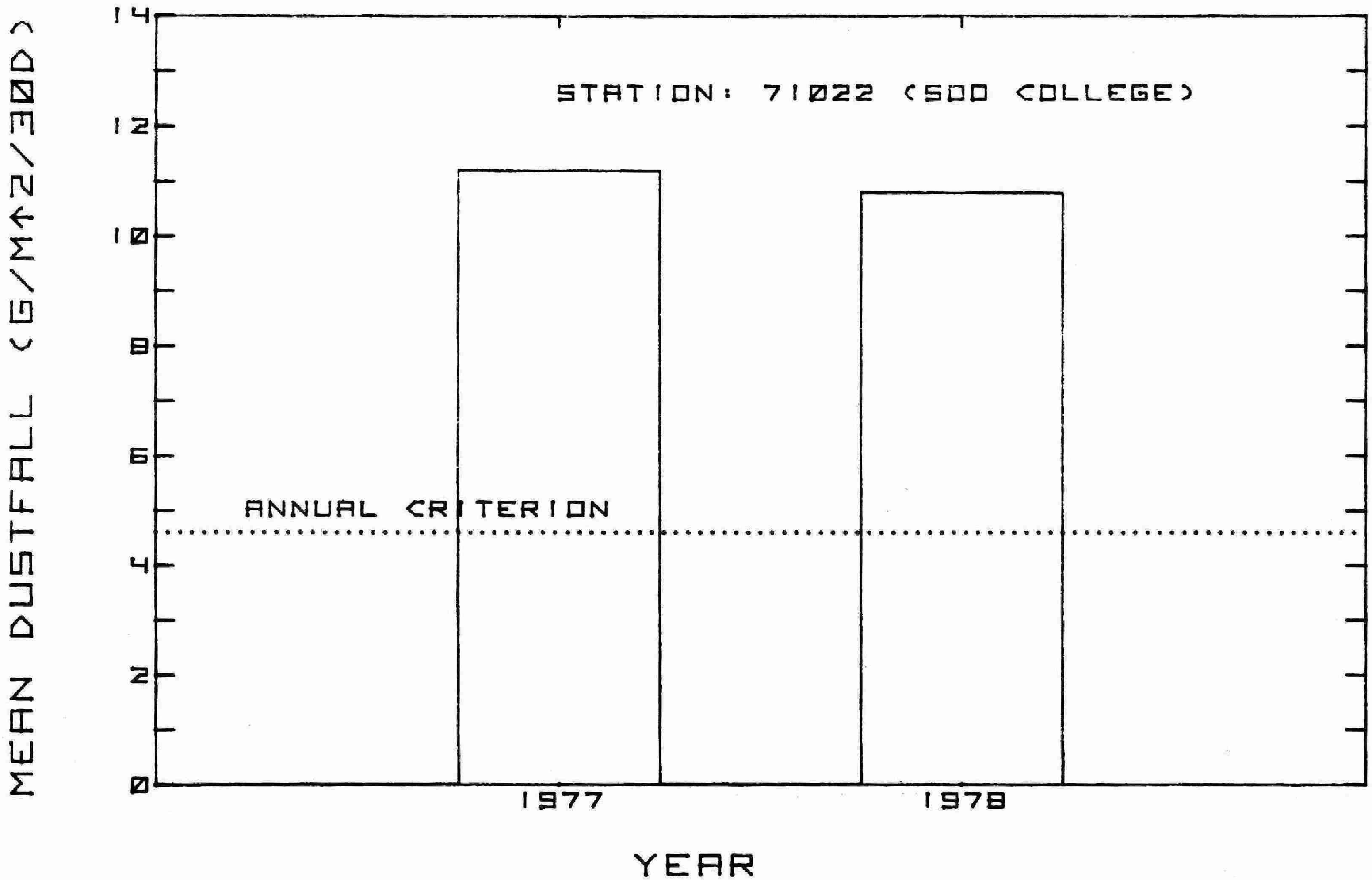


FIG. 11 ANNUAL MEAN DUSTFALL LEVELS

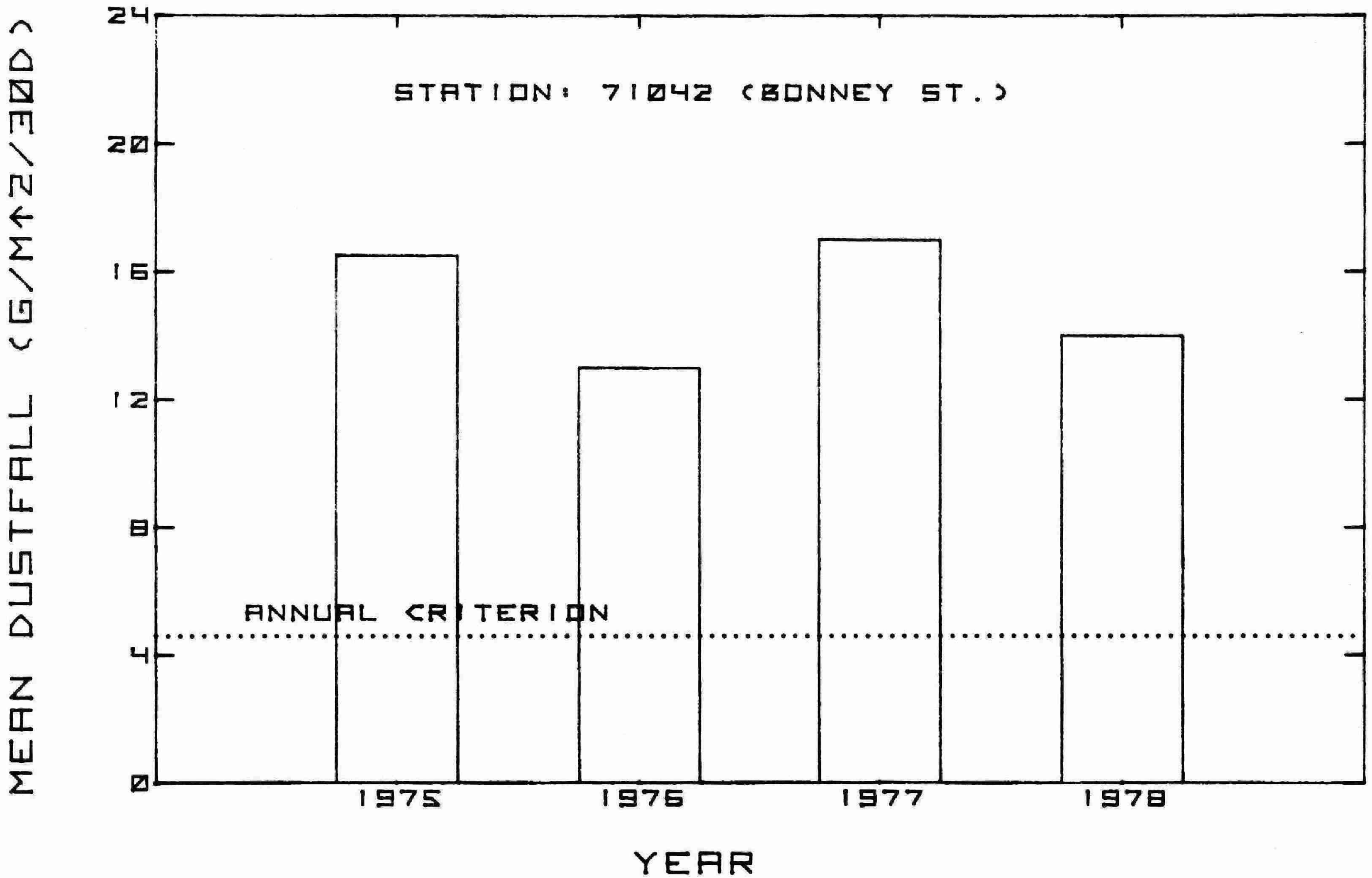


FIG. 12 ANNUAL MEAN DUSTFALL LEVELS

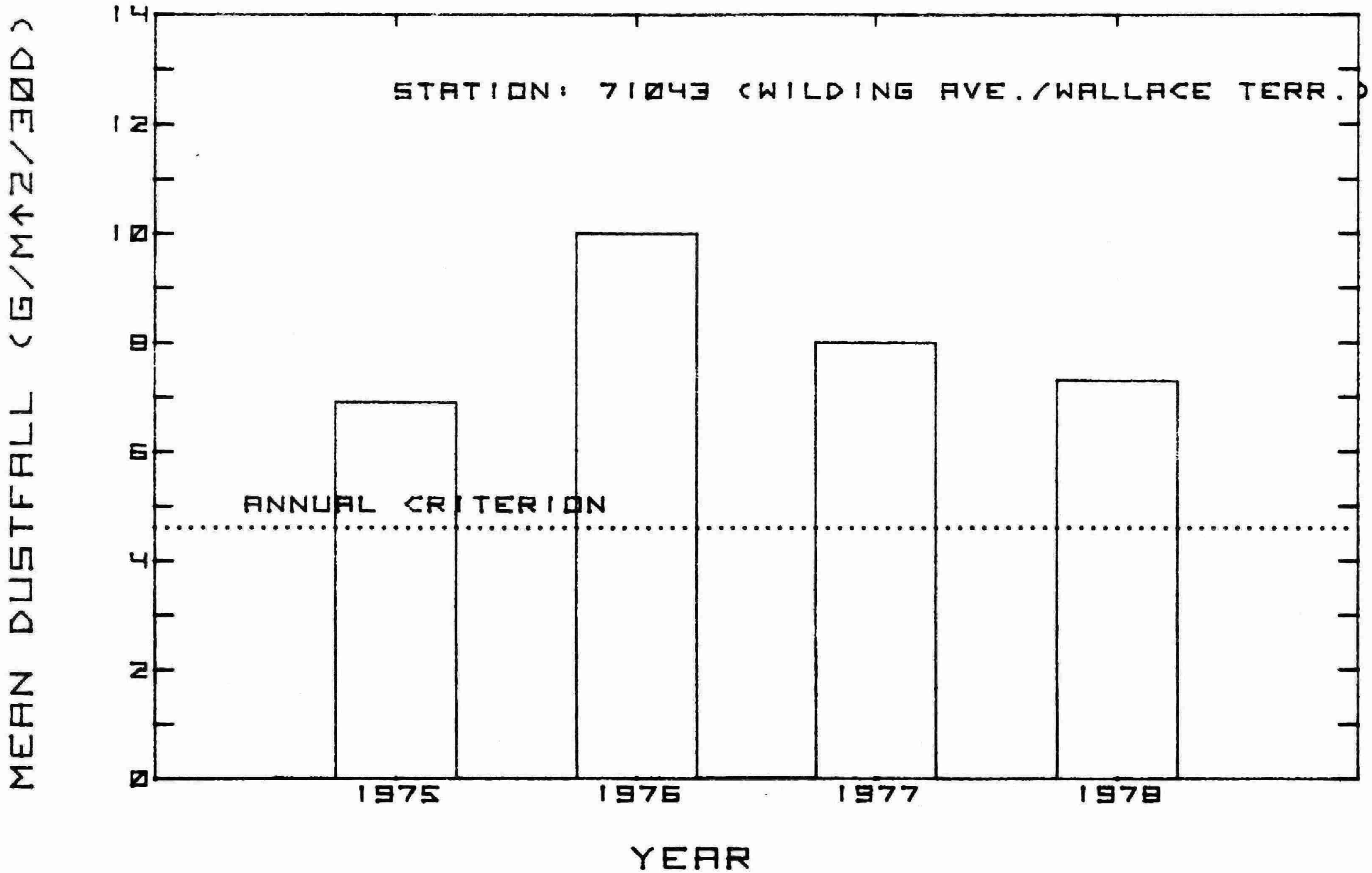


FIG. 13 ANNUAL MEAN DUSTFALL LEVELS

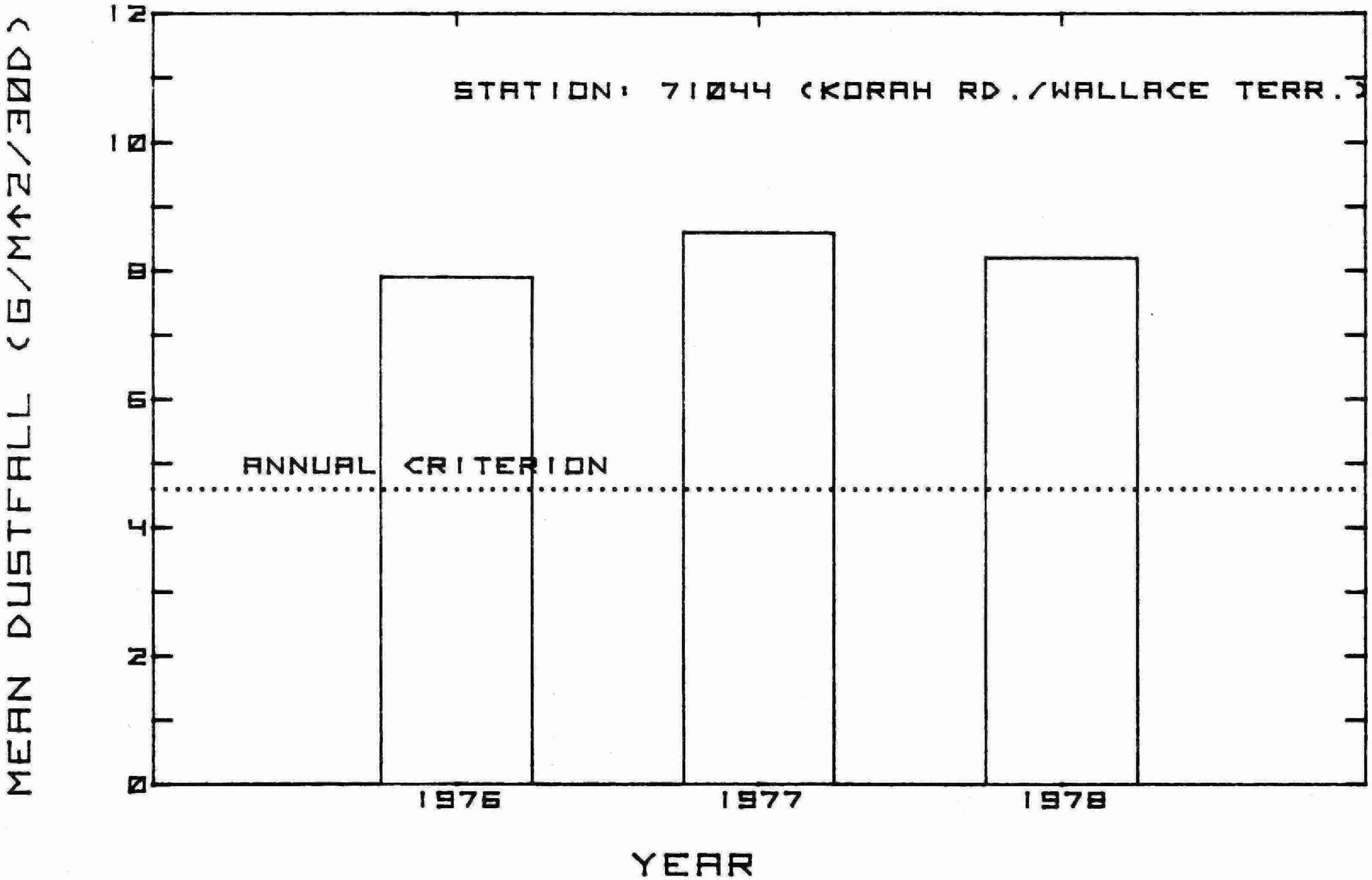


FIG. 14 ANNUAL MEAN DUSTFALL LEVELS

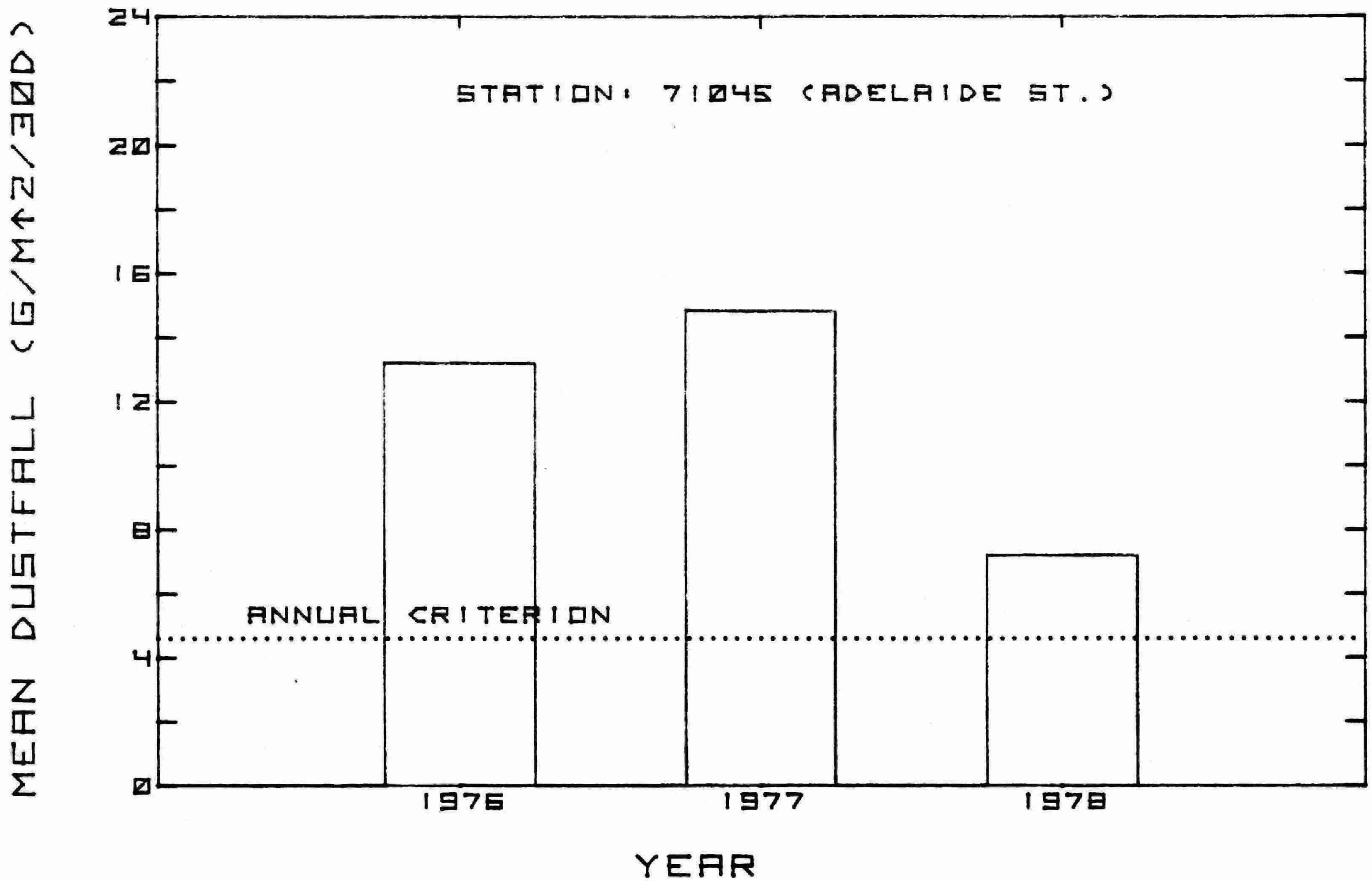


FIG. 15 ANNUAL MEAN DUSTFALL LEVELS

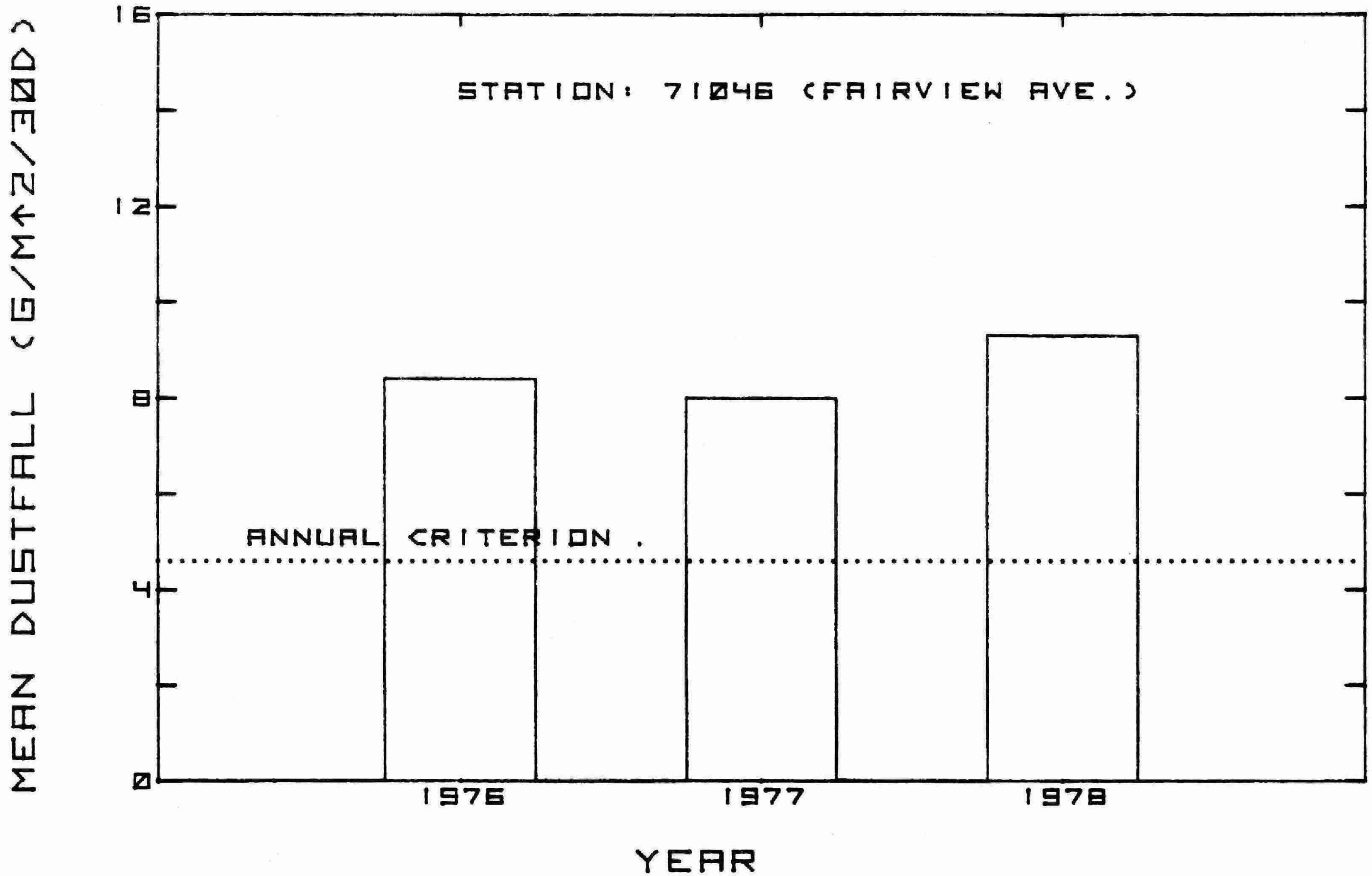


FIG. 16 ANNUAL MEAN DUSTFALL LEVELS

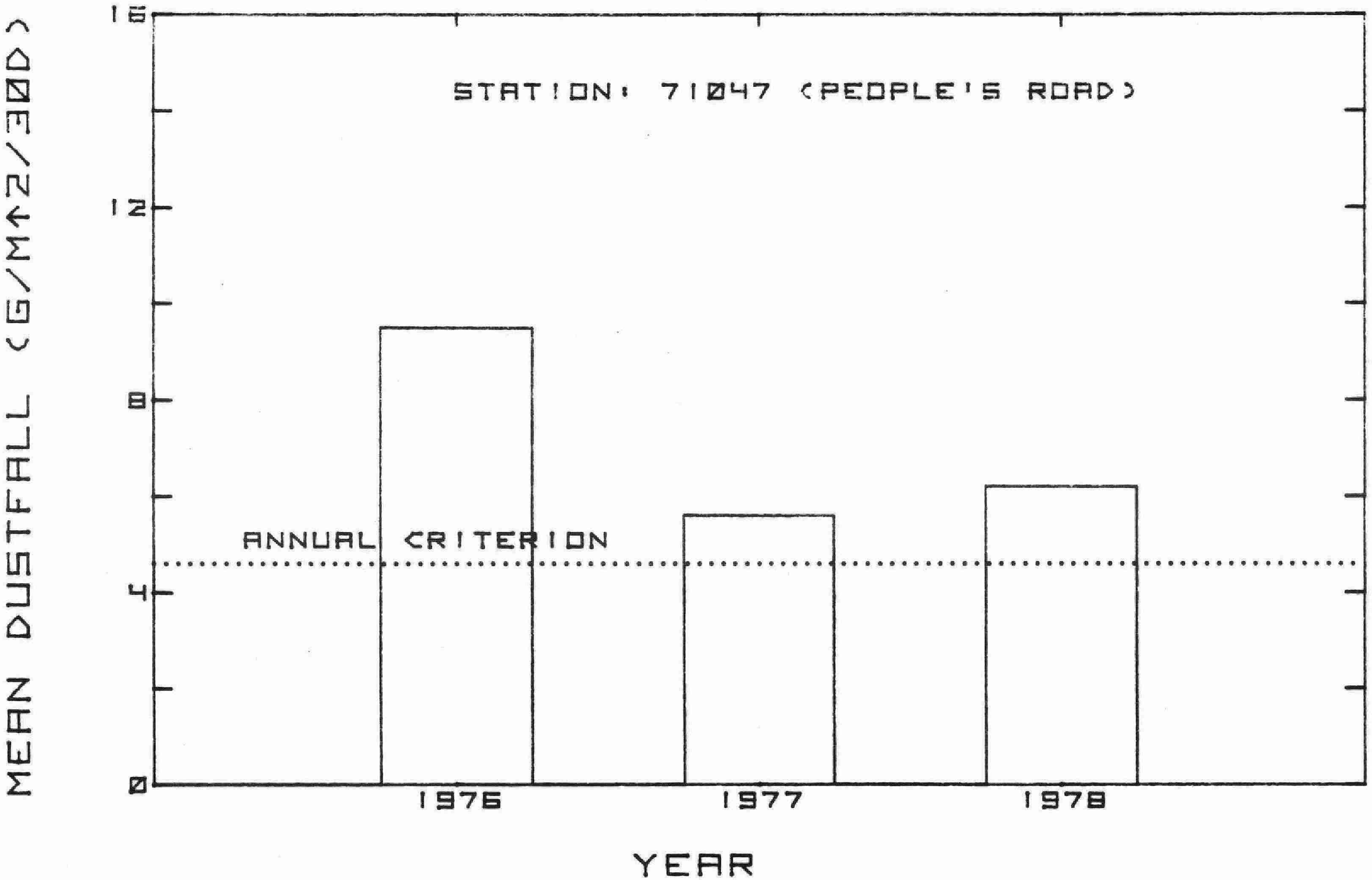


FIG. 17 ANNUAL MEAN DUSTFALL LEVELS

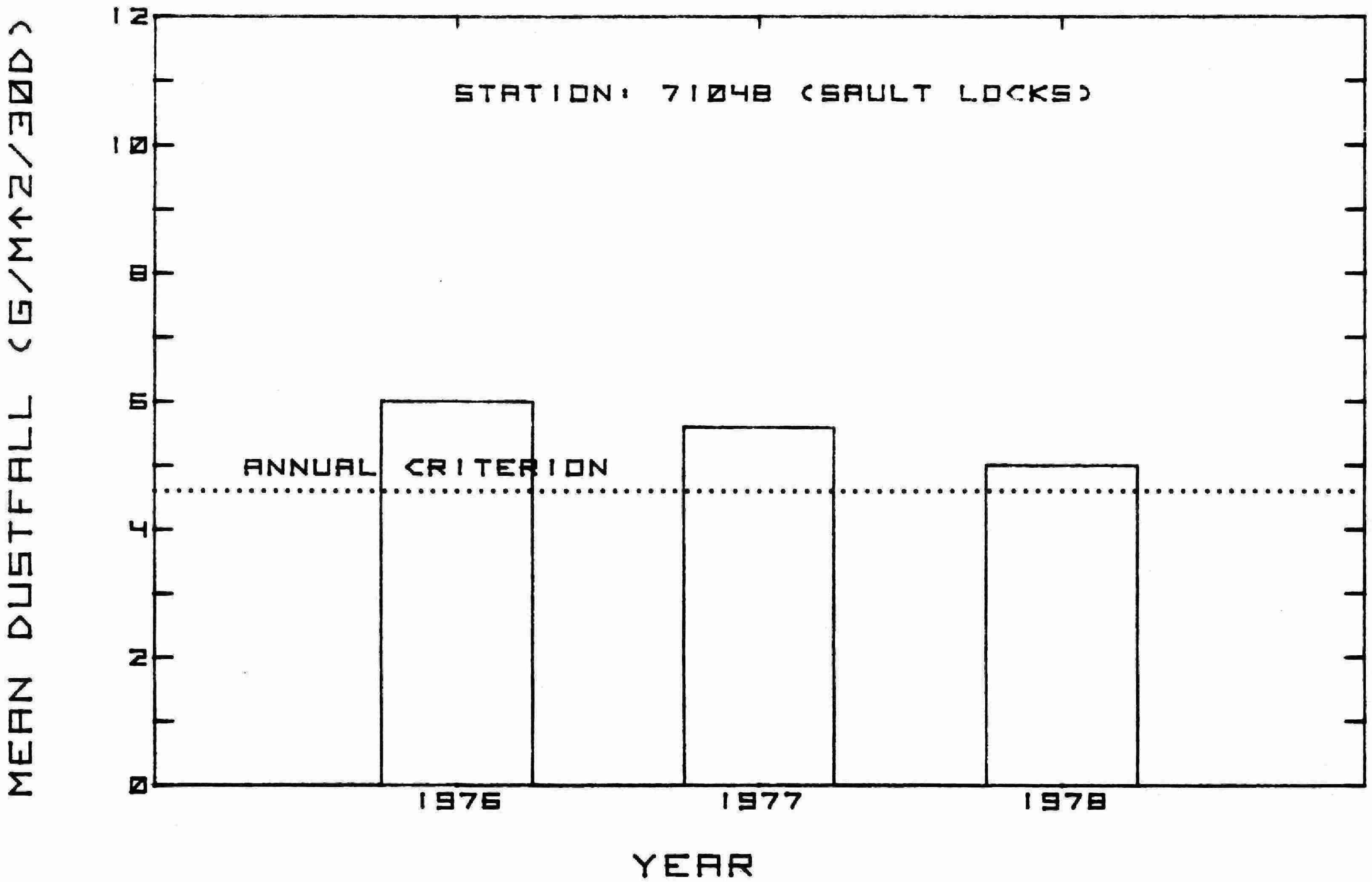


FIG. 18 ANNUAL MEAN DUSTFALL LEVELS

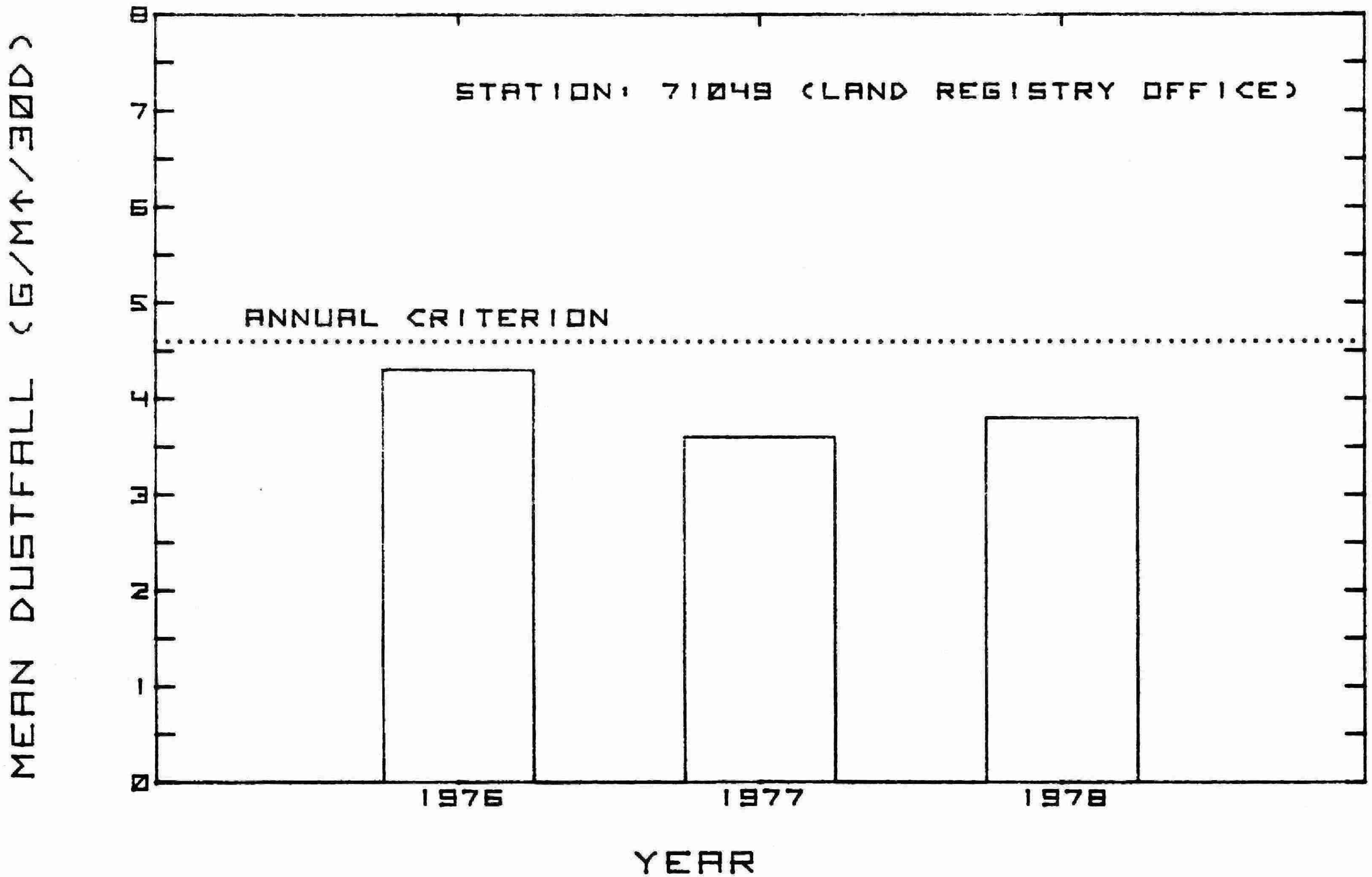


FIG. 19 ANNUAL MEAN DUSTFALL LEVELS

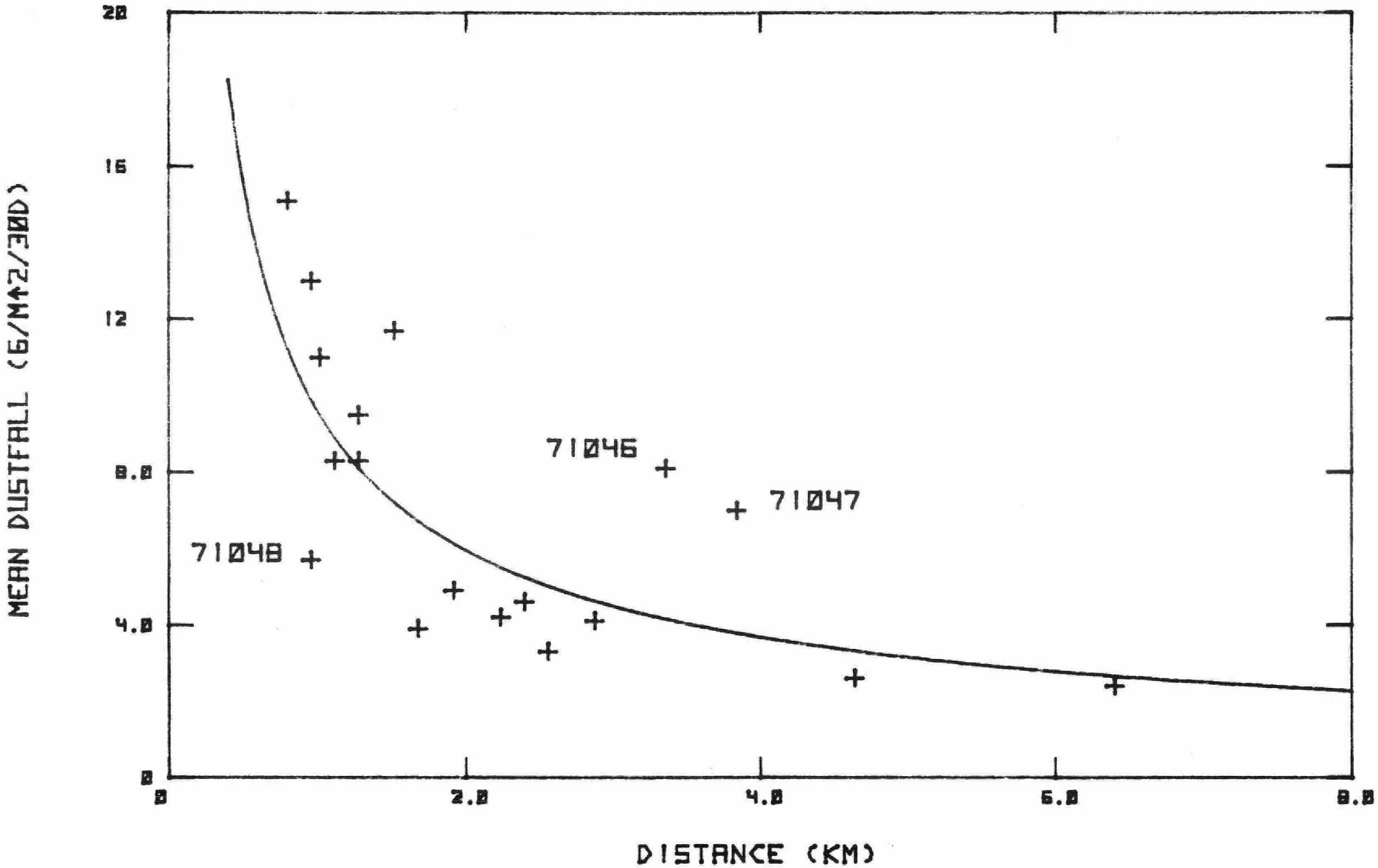


FIG. 20 MEAN DUSTFALL VS DISTANCE FROM ALGOMA STEEL

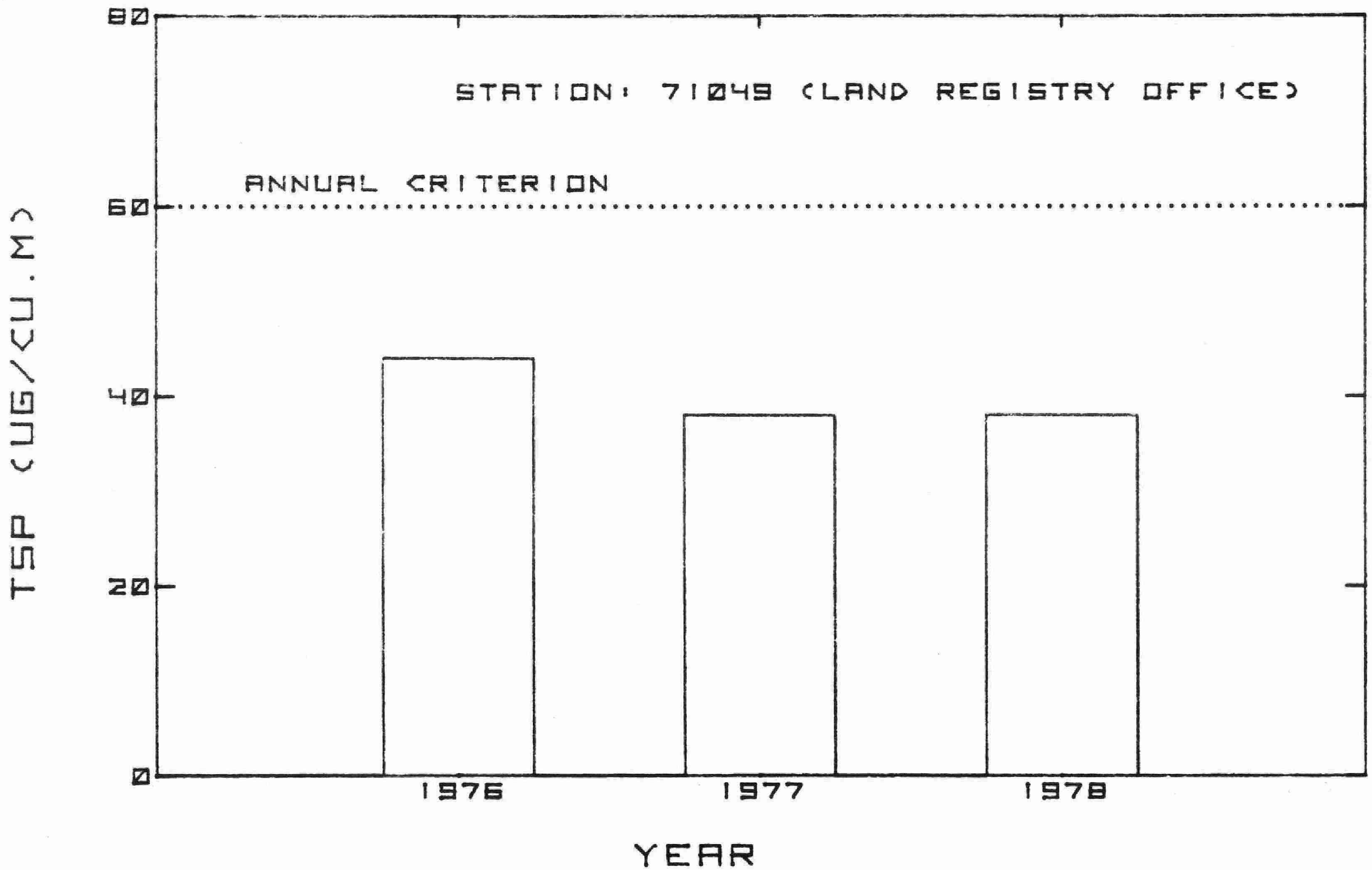


FIG. 21 ANNUAL GEOMETRIC MEAN TSP LEVELS

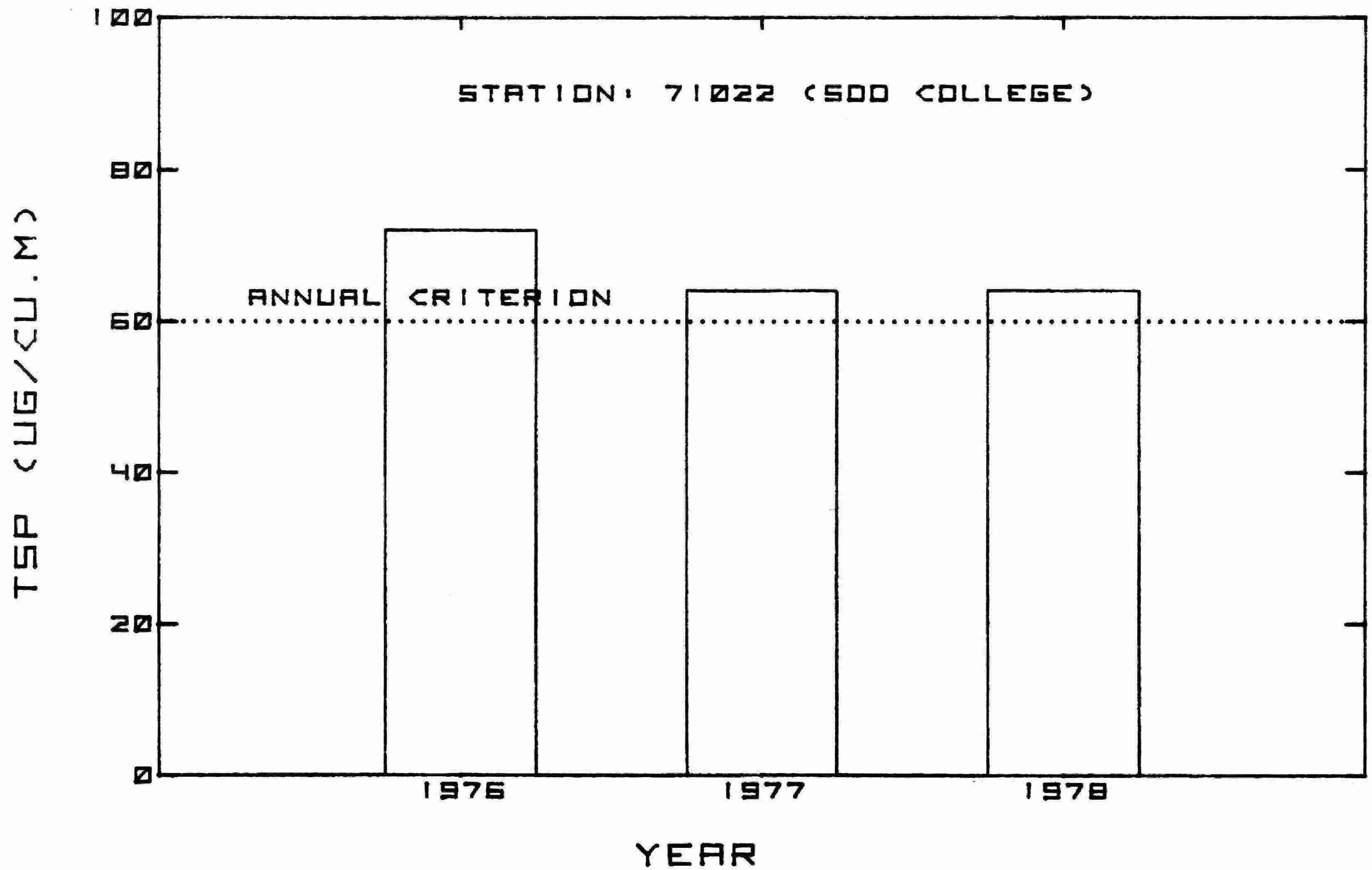


FIG. 22 ANNUAL GEOMETRIC MEAN TSP LEVELS

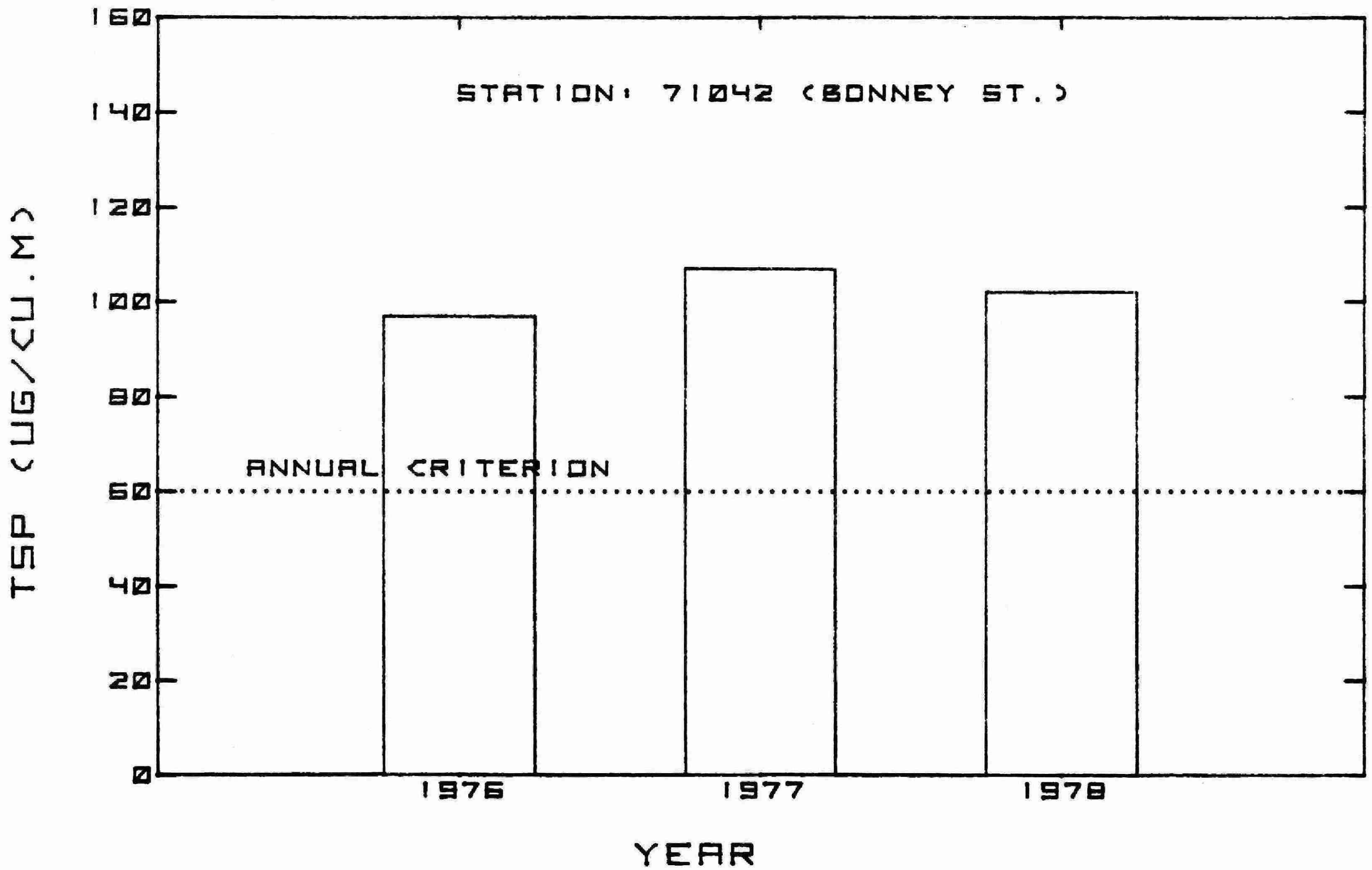


FIG. 23 ANNUAL GEOMETRIC MEAN TSP LEVELS

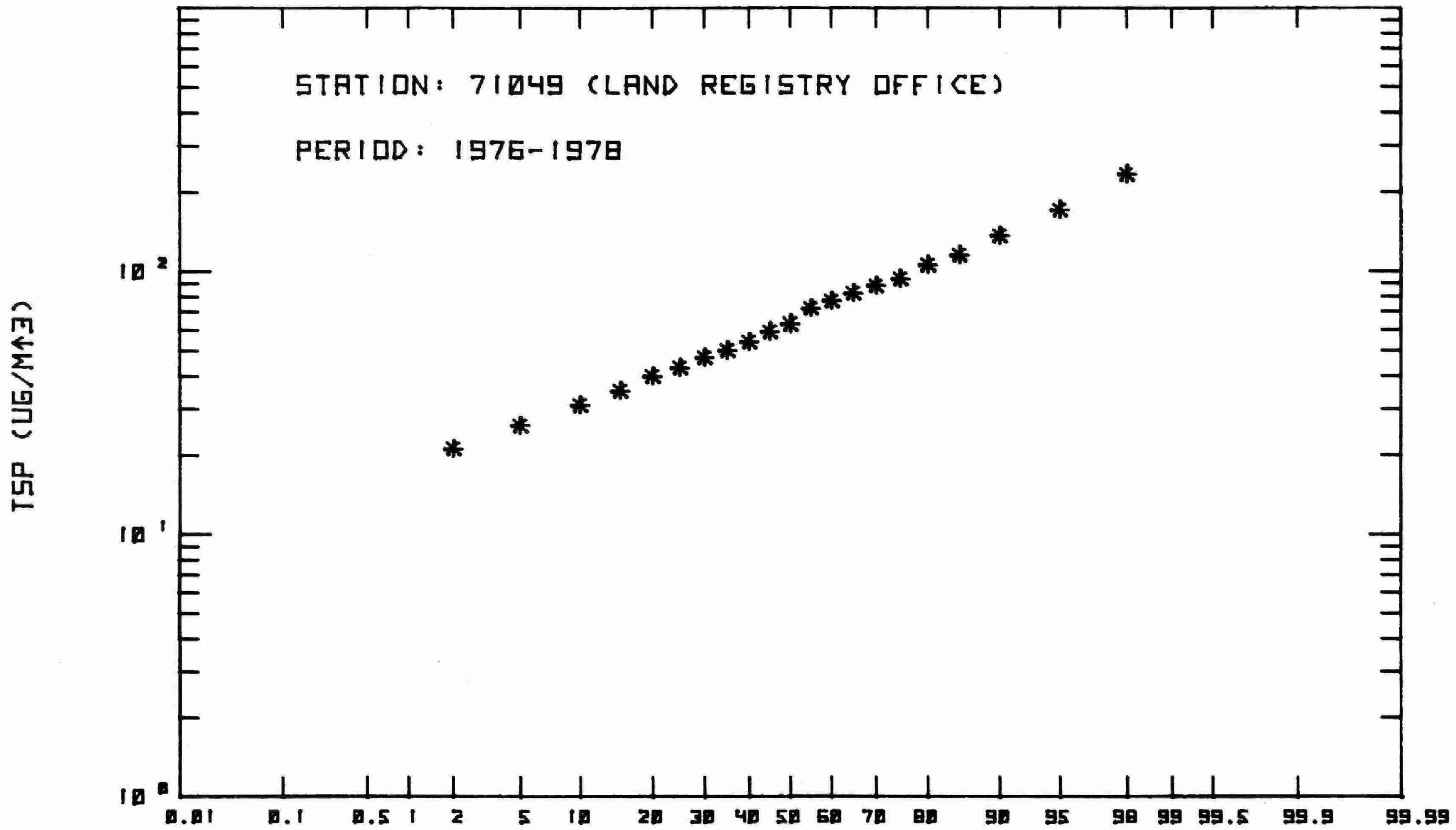


FIG. 24 TSP PERCENTILE FREQUENCY DISTRIBUTION

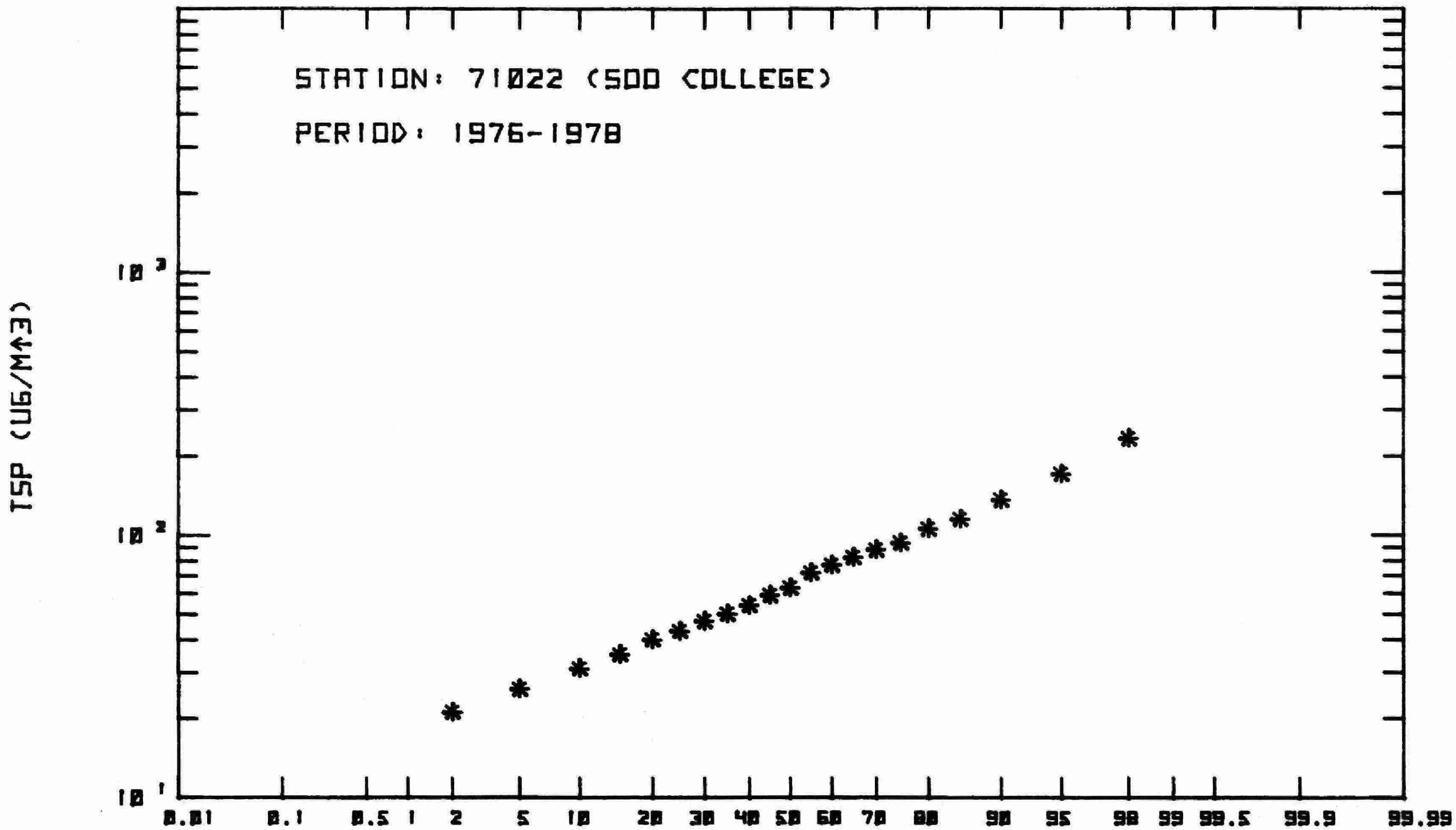


FIG. 25 TSP PERCENTILE FREQUENCY DISTRIBUTION

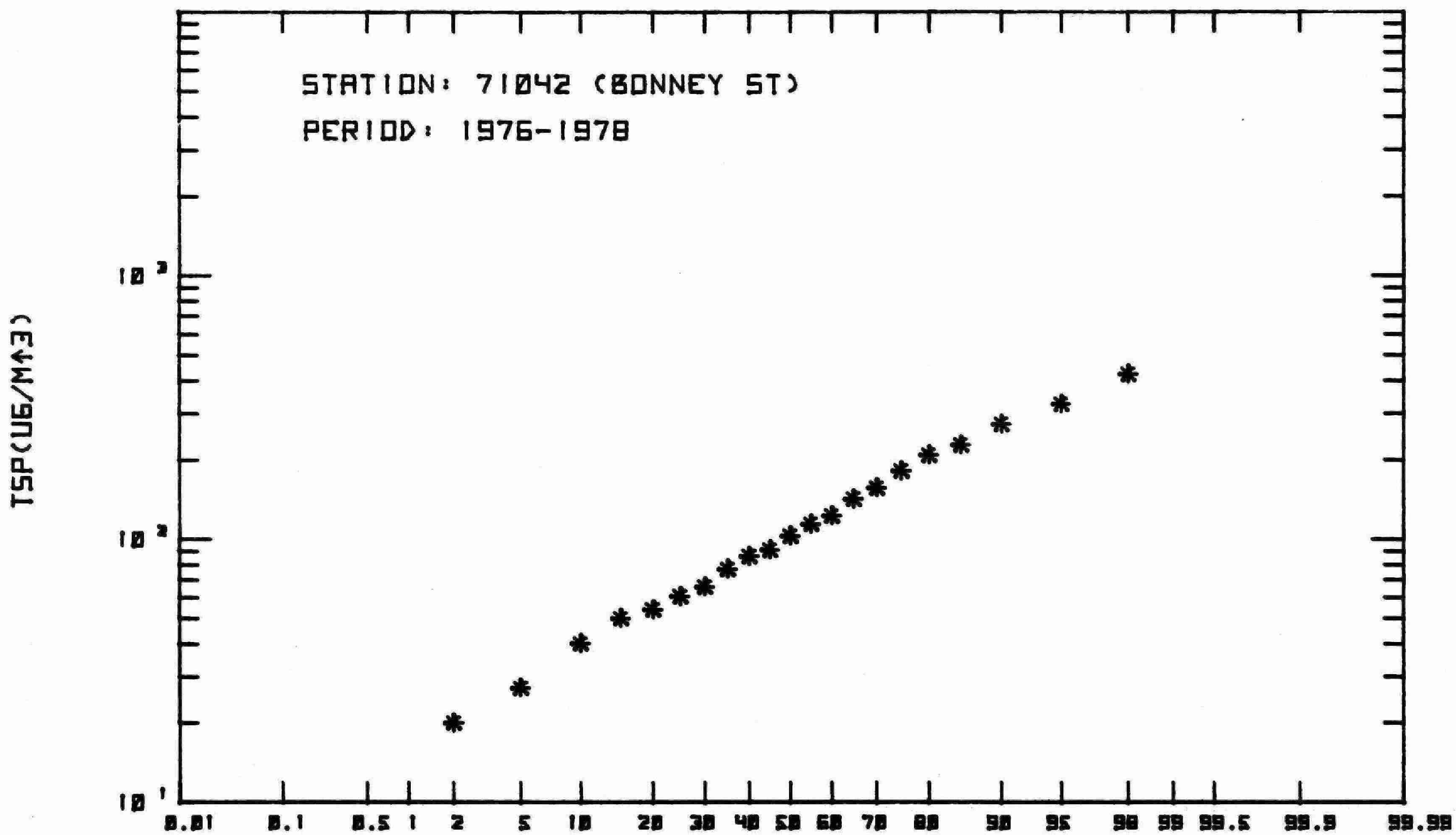


FIG. 26 TSP PERCENTILE FREQUENCY DISTRIBUTION

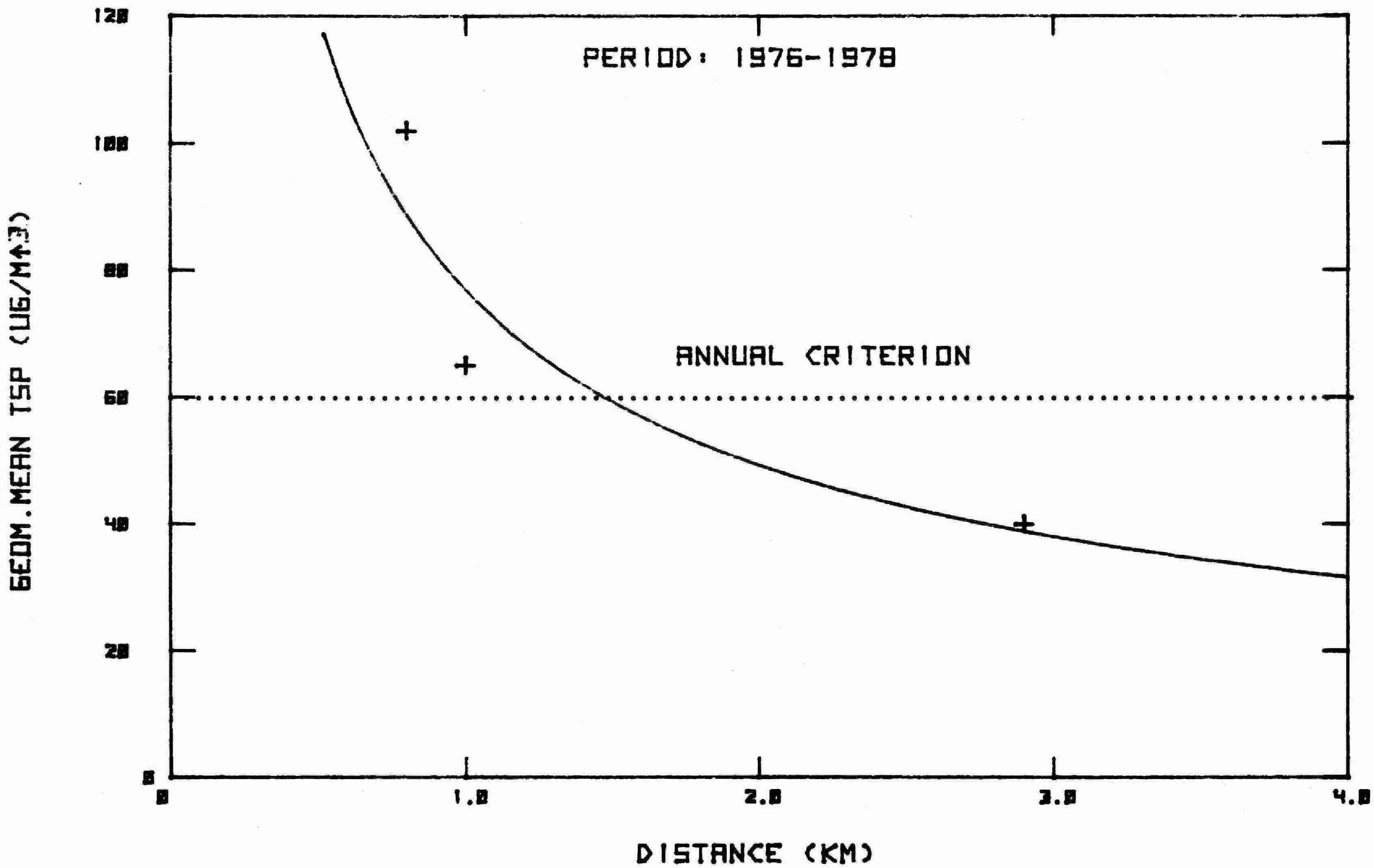


FIG. 27 TSP LEVELS VS DISTANCE FROM ALGOMA STEEL

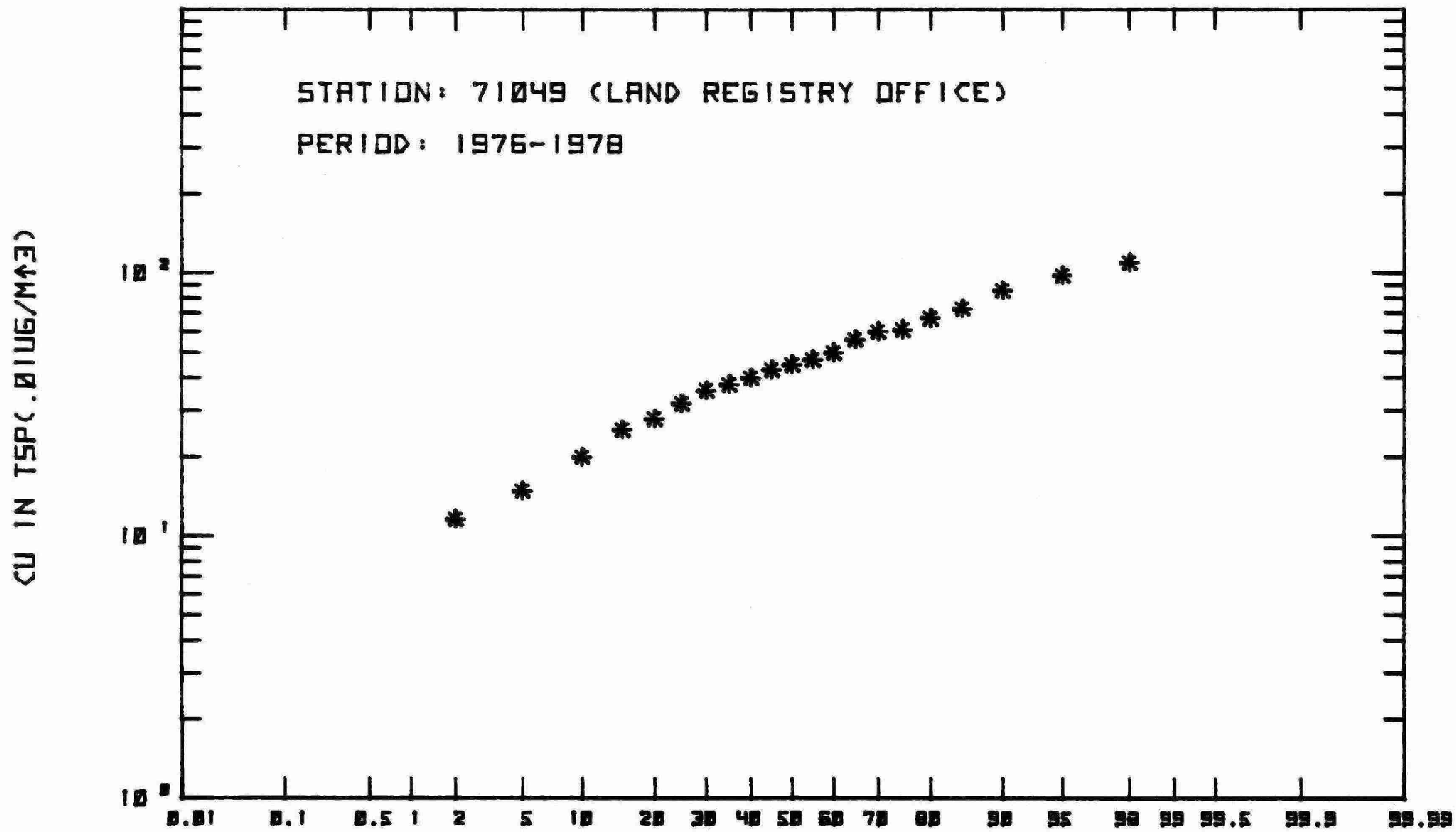


FIG. 28 PERCENTILE FREQUENCY DISTRIBUTION FOR CU IN TSP

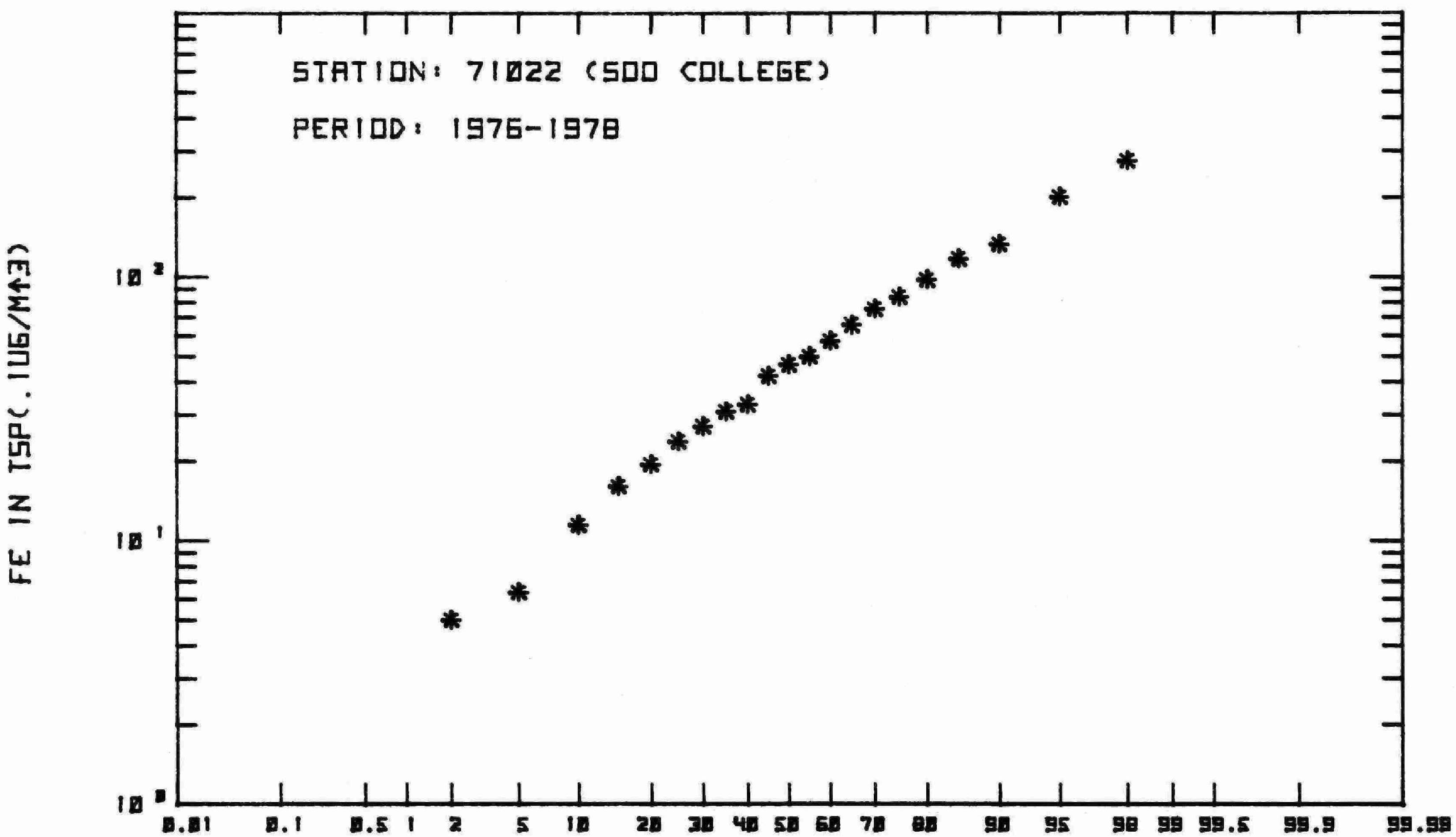


FIG. 29 PERCENTILE FREQUENCY DISTRIBUTION FOR FE IN TSP

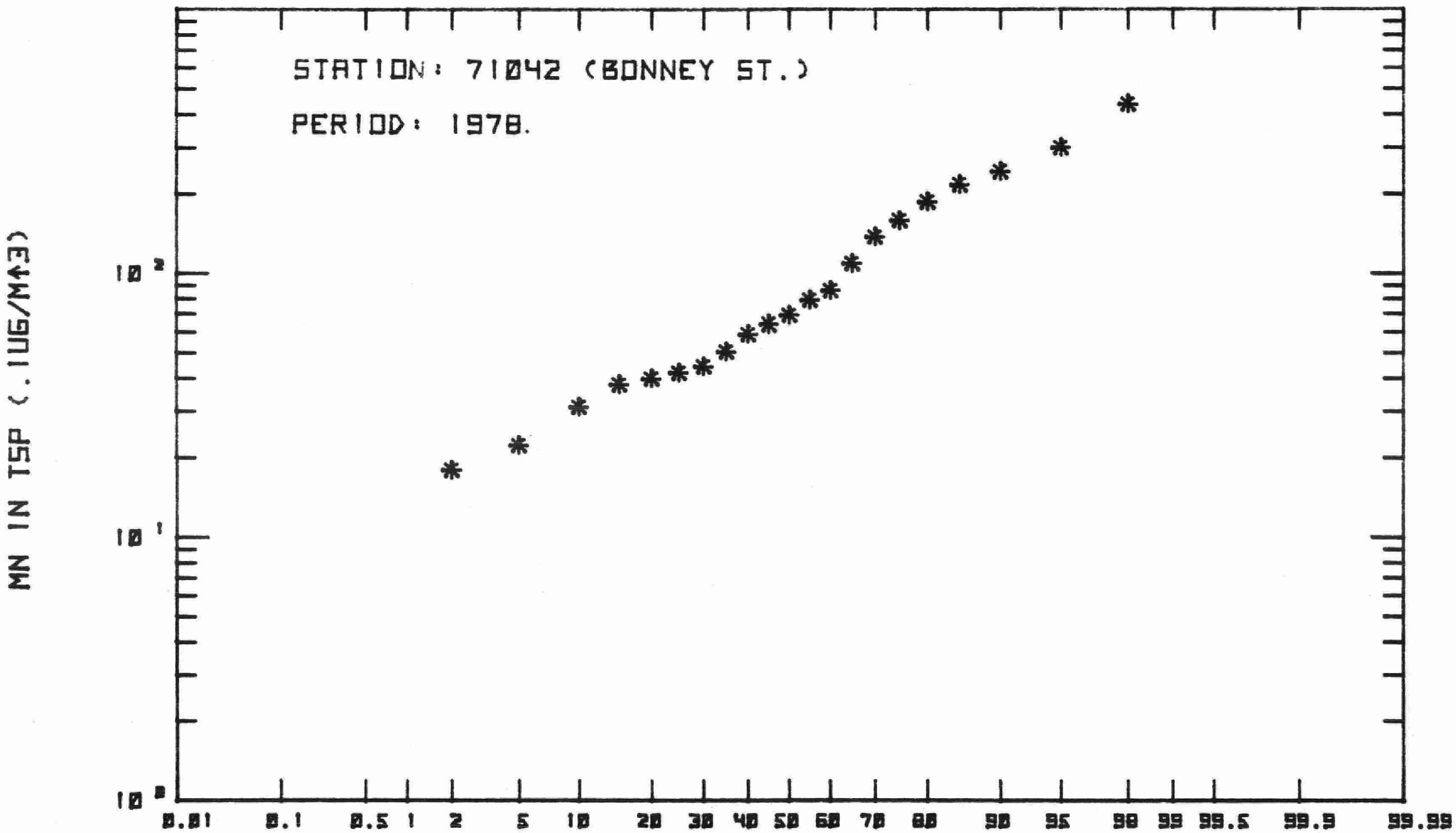


FIG. 30 PERCENTILE FREQUENCY DISTRIBUTION FOR MN IN TSP

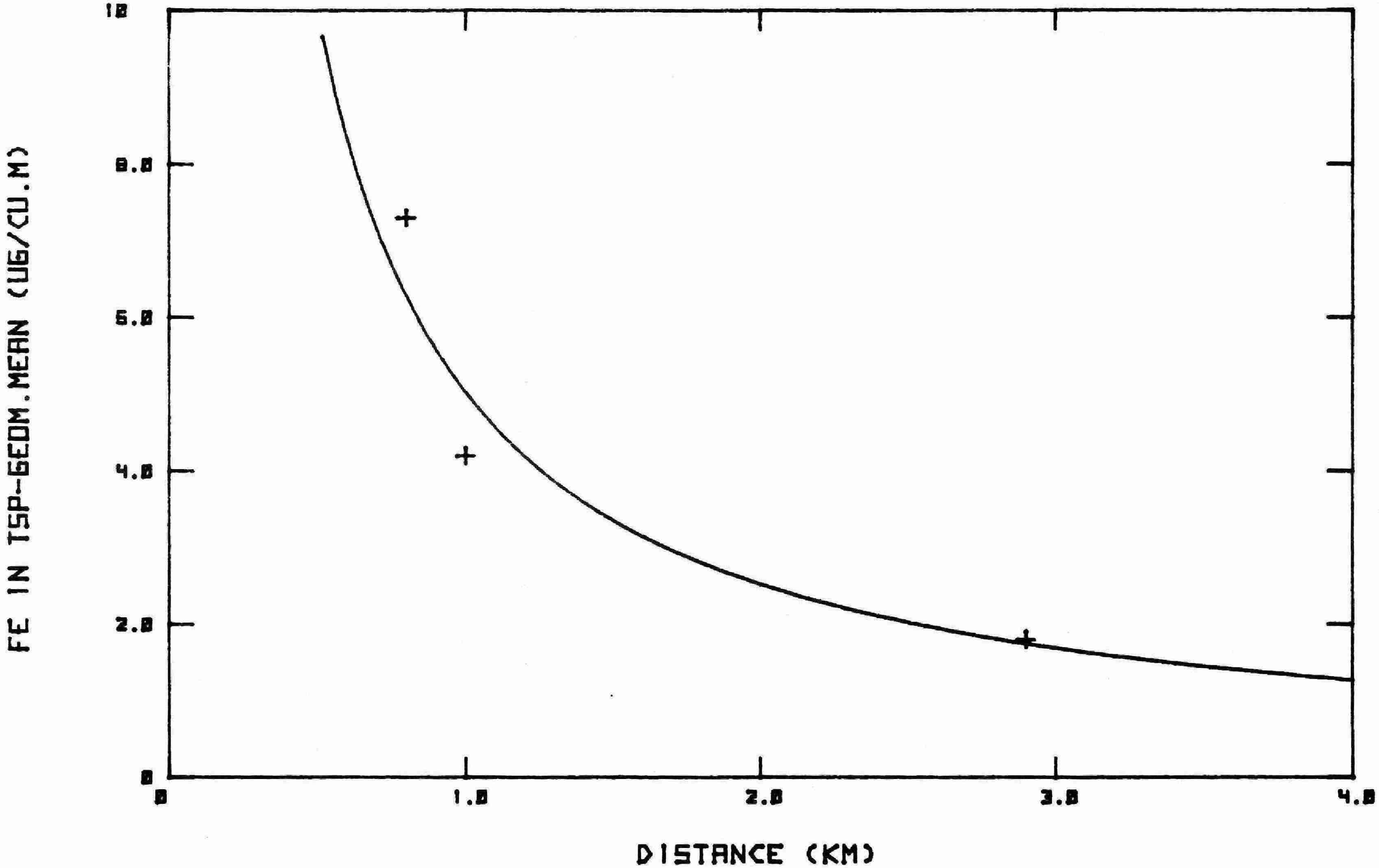


FIG. 31 FE IN TSP VS DISTANCE FROM ALGOMA STEEL

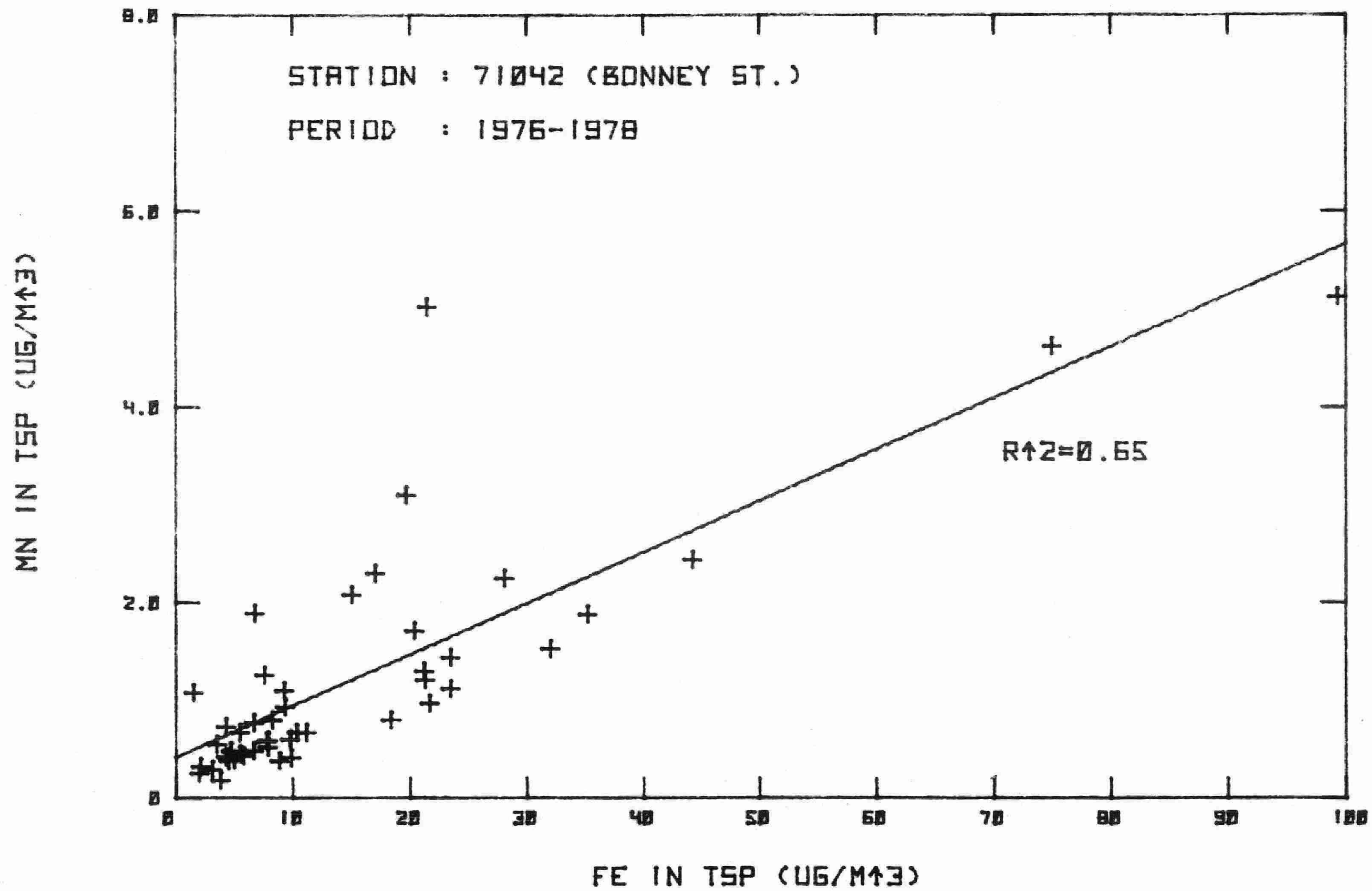


FIG. 32 CORRELATION OF MN WITH FE IN TSP

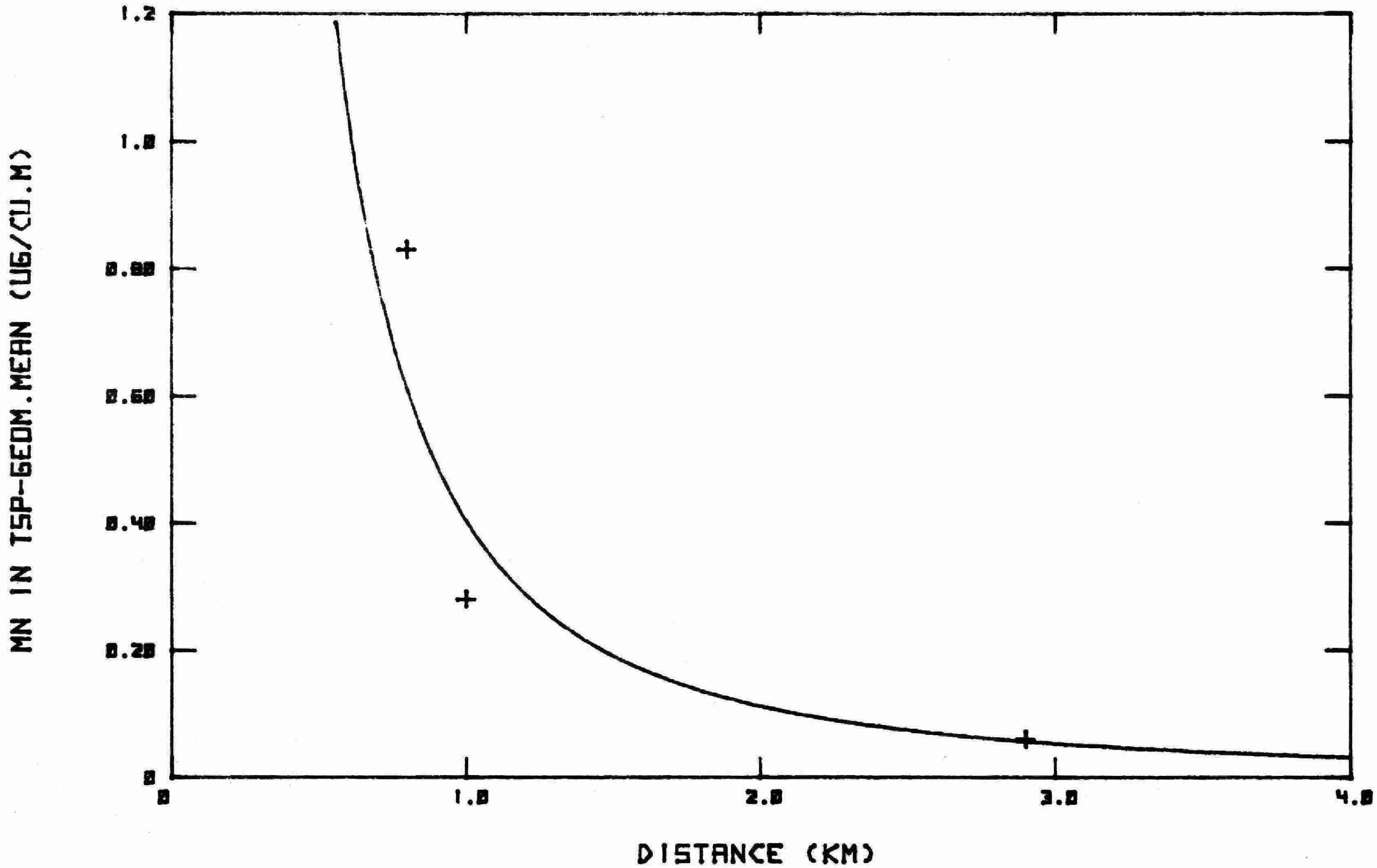


FIG. 33 MN IN TSP VS DISTANCE FROM ALGOMA STEEL (1978)

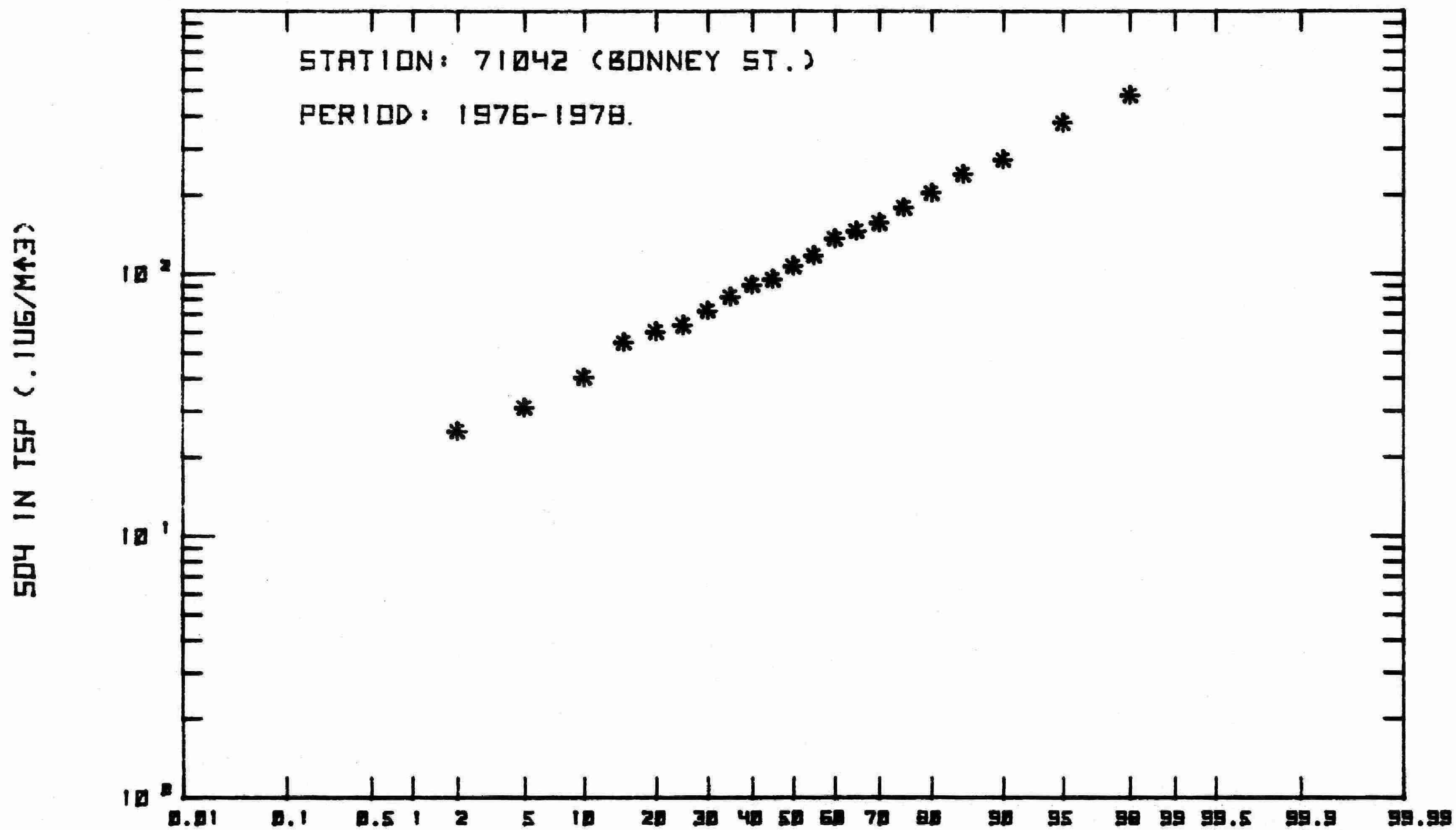


FIG. 34 PERCENTILE FREQUENCY DISTRIBUTION FOR SO4 IN TSP

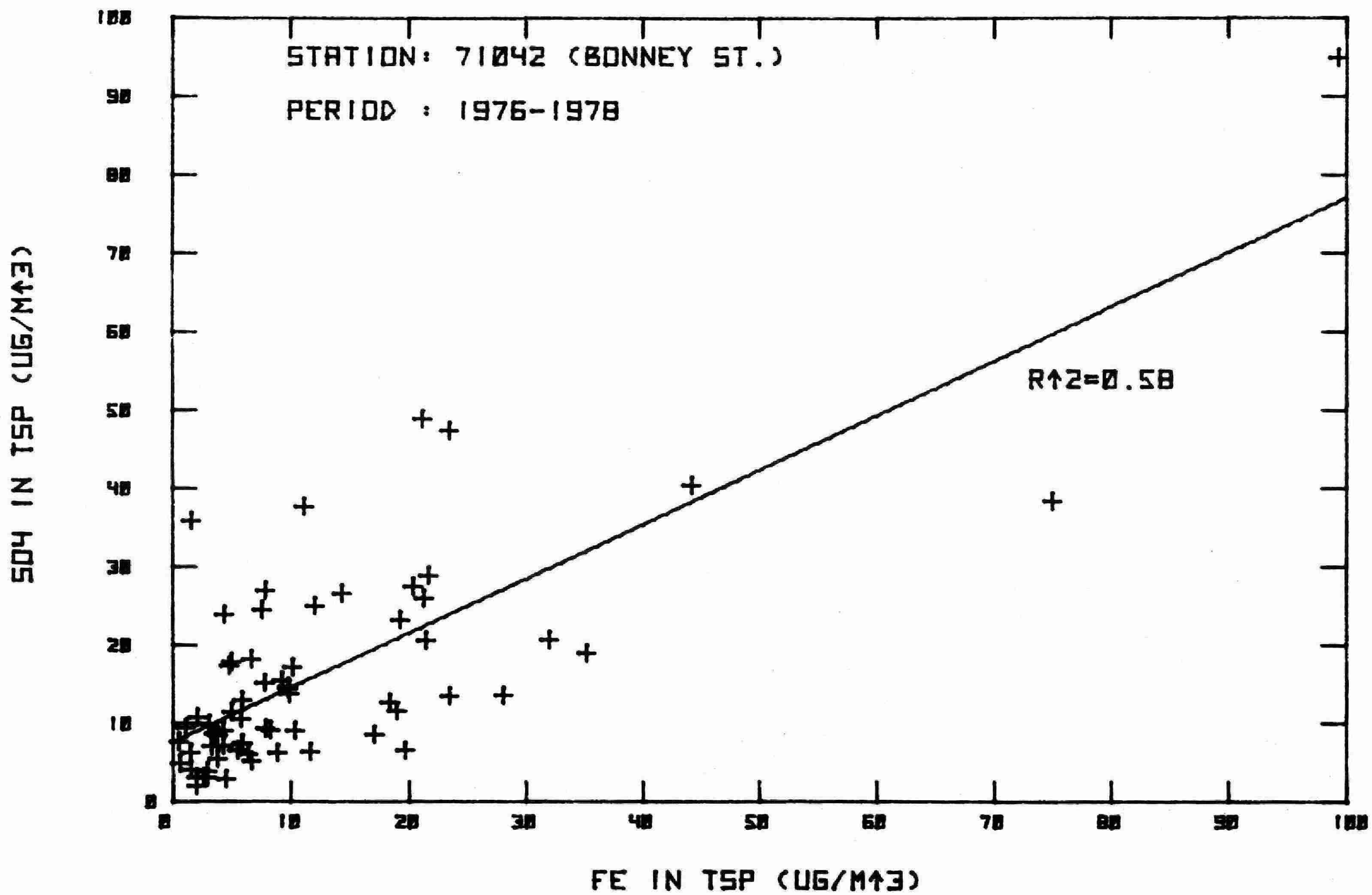


FIG. 35 CORRELATION OF SO4 WITH FE IN TSP

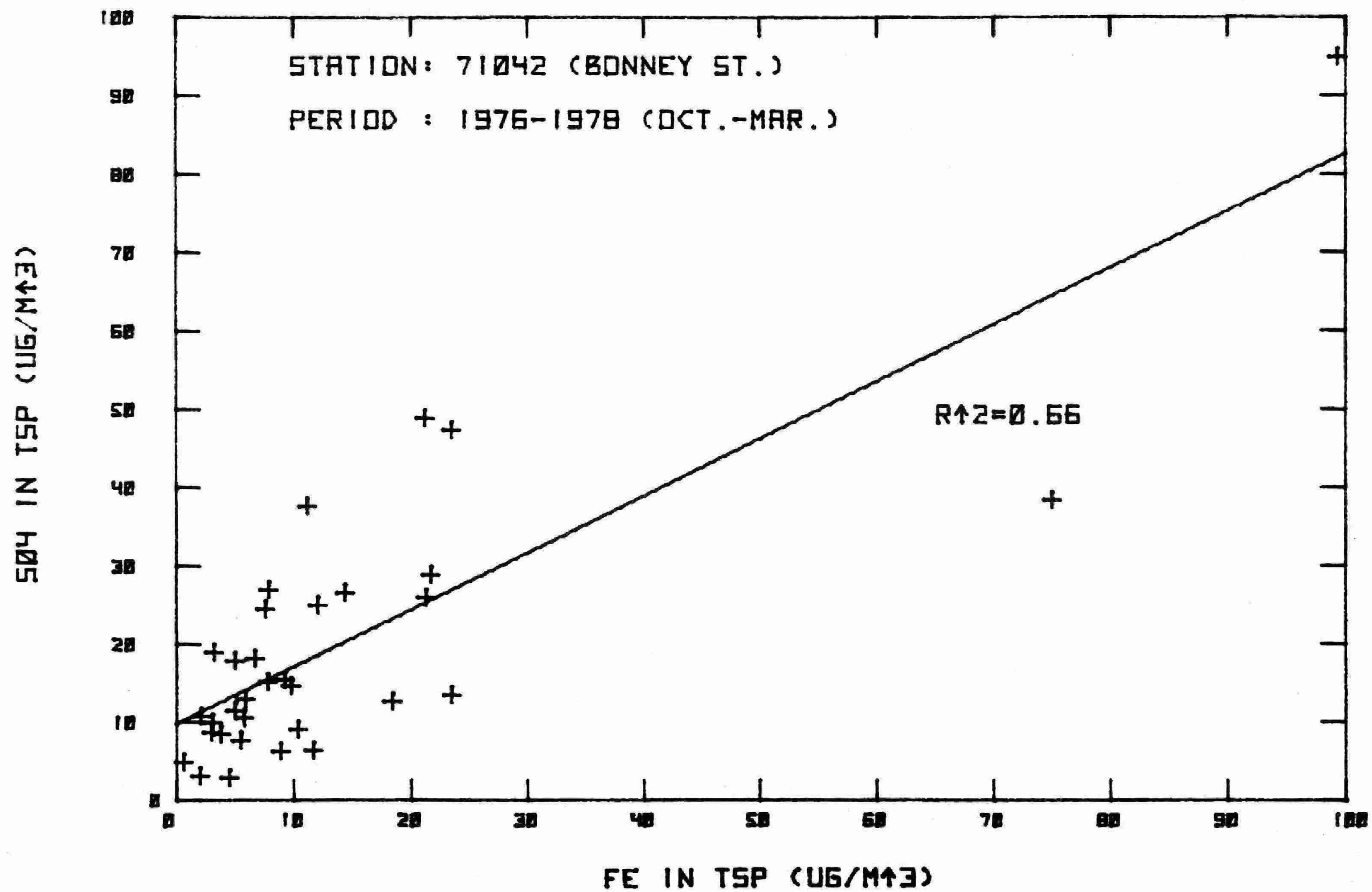


FIG. 36 CORRELATION OF SO4 WITH FE IN TSP

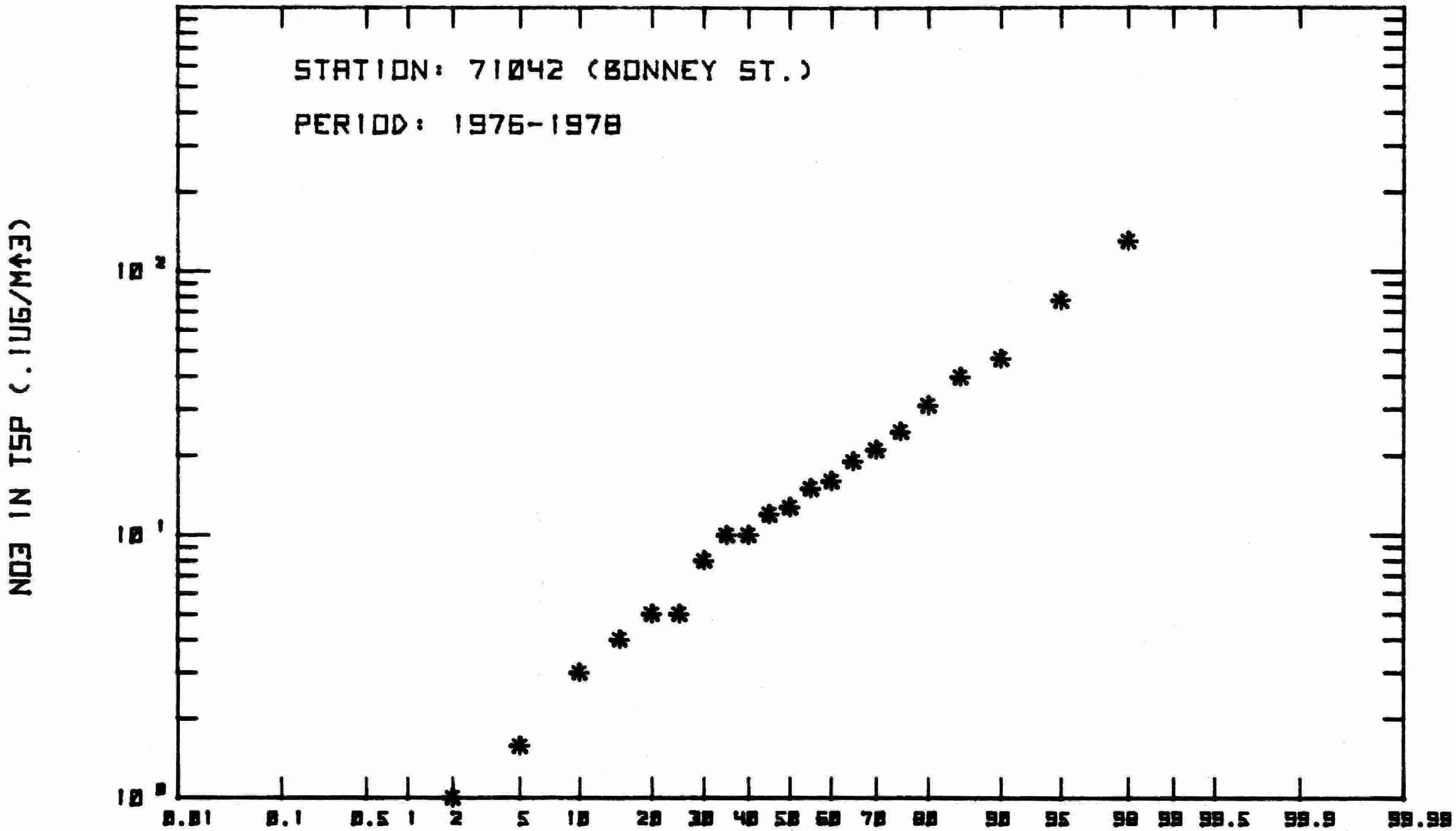


FIG. 37 PERCENTILE FREQUENCY DISTRIBUTION FOR NO3 IN TSP

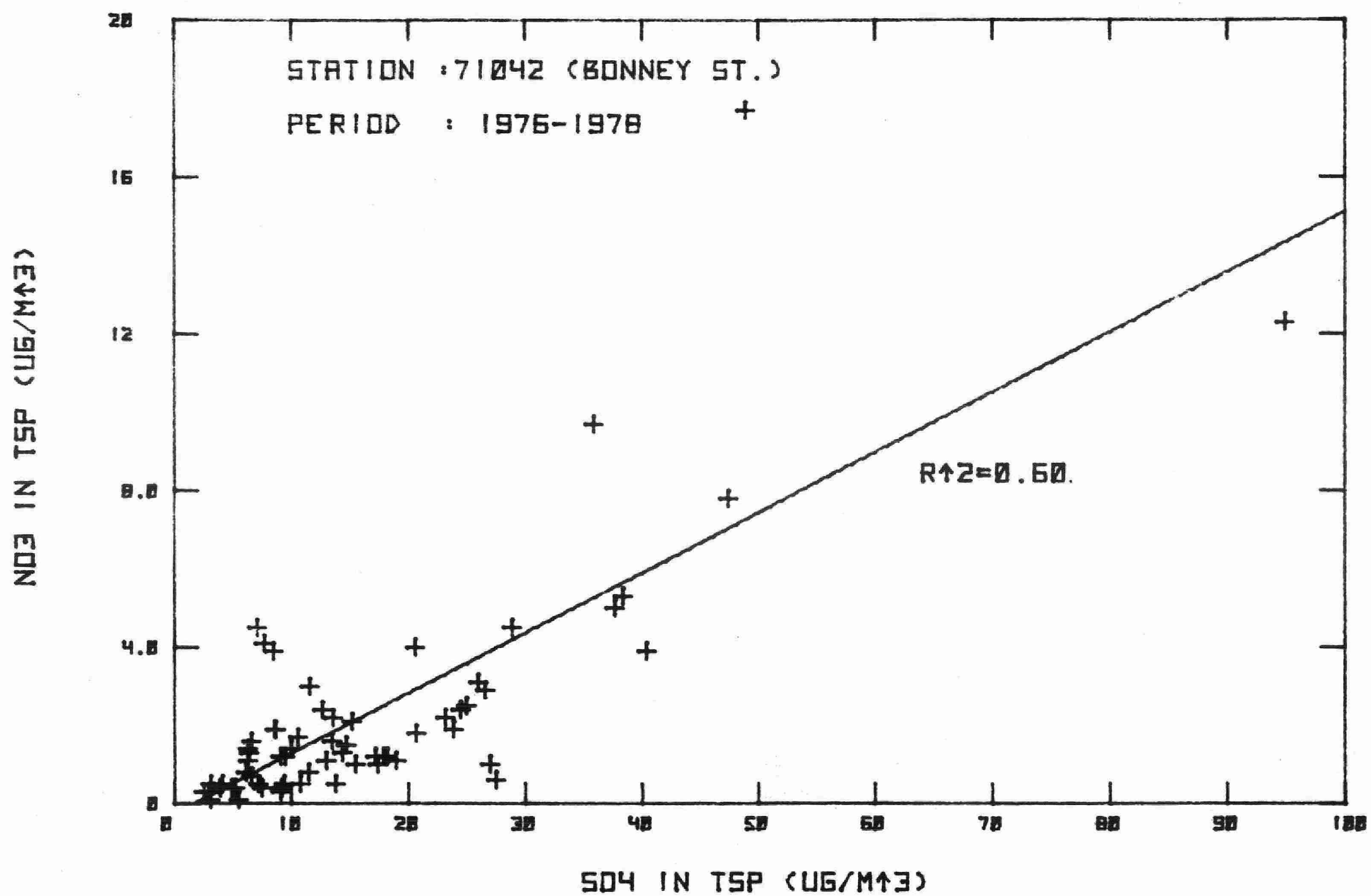


FIG. 38 CORRELATION OF NO3 WITH SO4 IN TSP

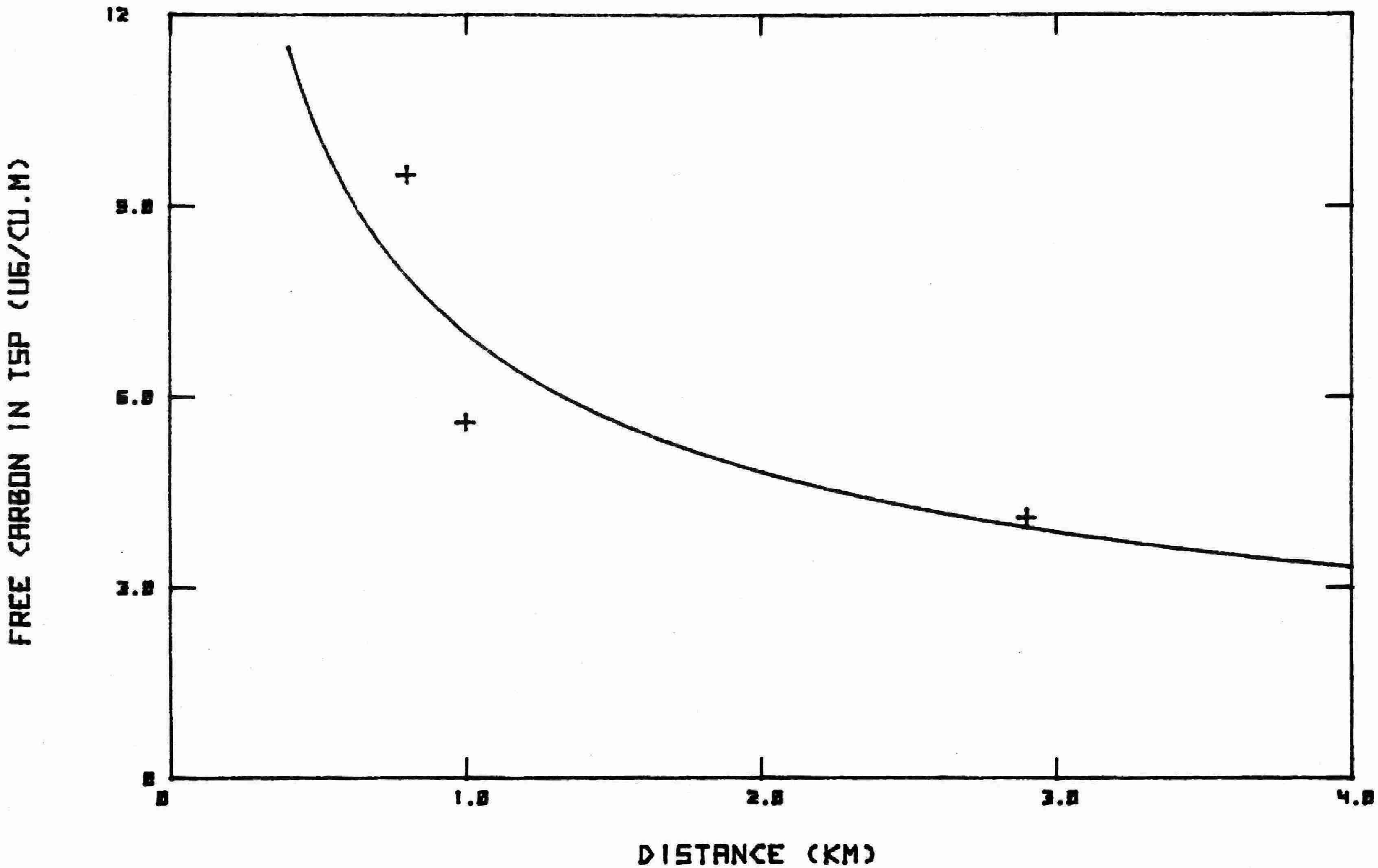


FIG. 39 FREE CARBON VS DISTANCE FROM ALGOMA STEEL

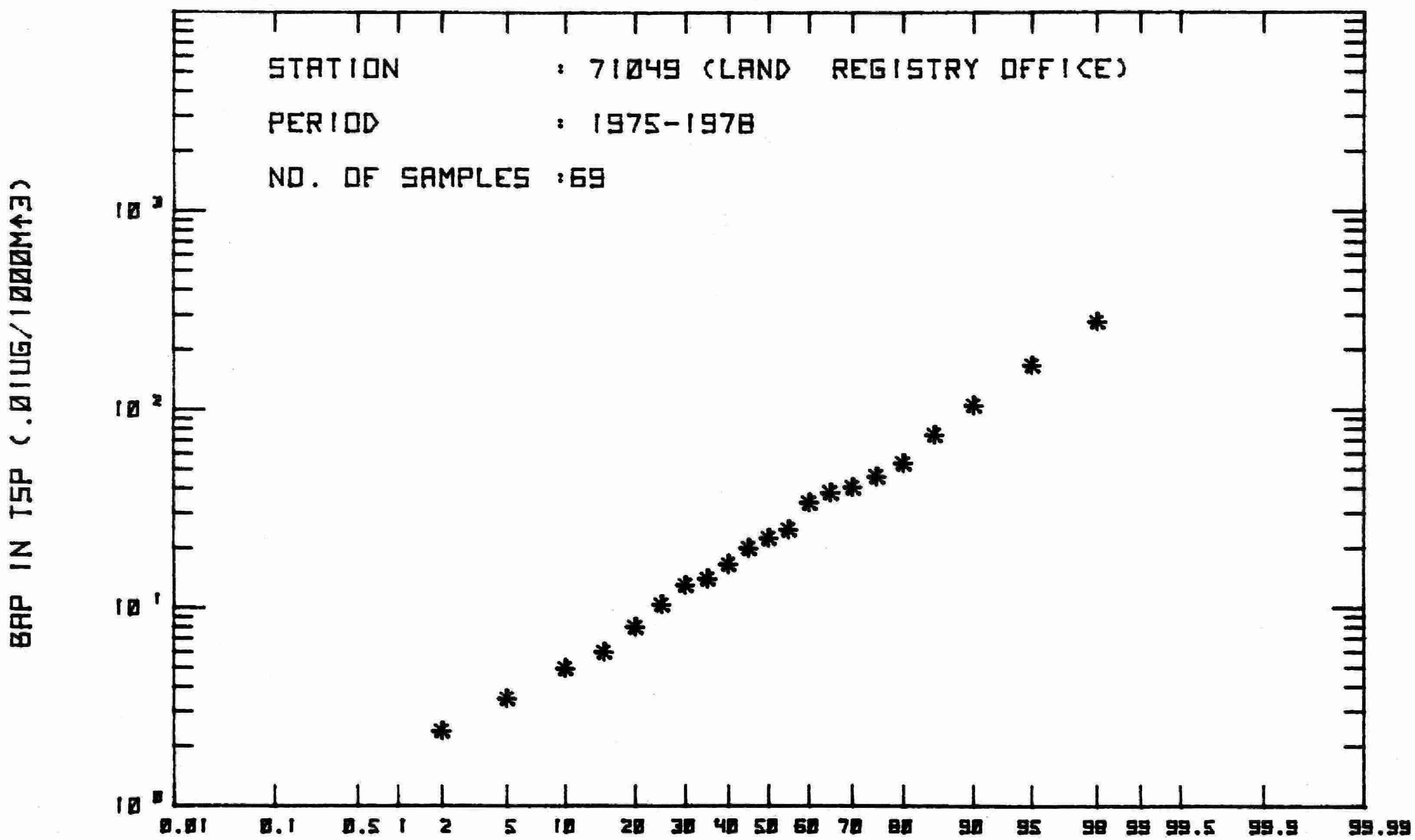


FIG. 40 PERCENTILE FREQUENCY DISTRIBUTION FOR BAP IN TSP

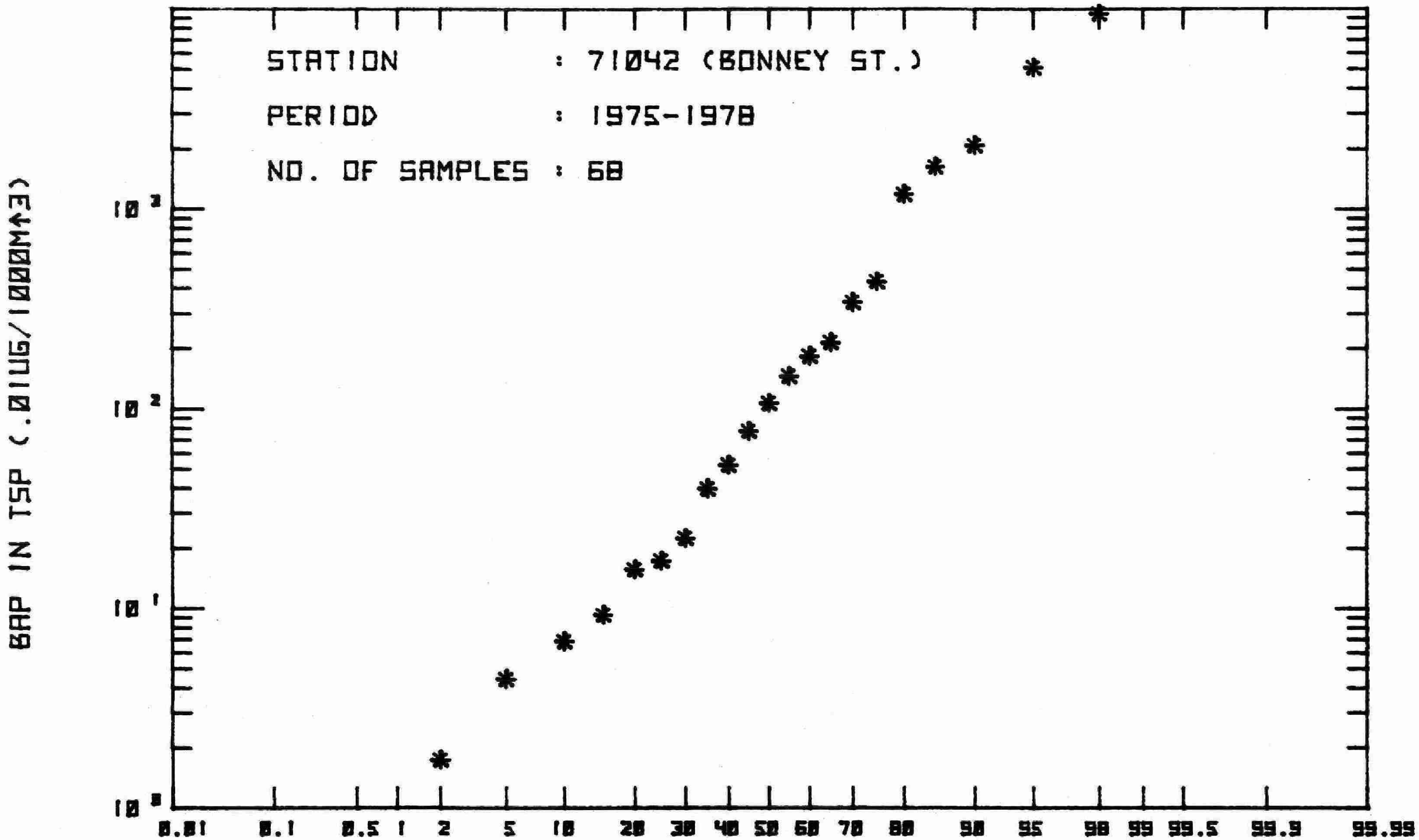


FIG. 41 PERCENTILE FREQUENCY DISTRIBUTION FOR BAP IN TSP

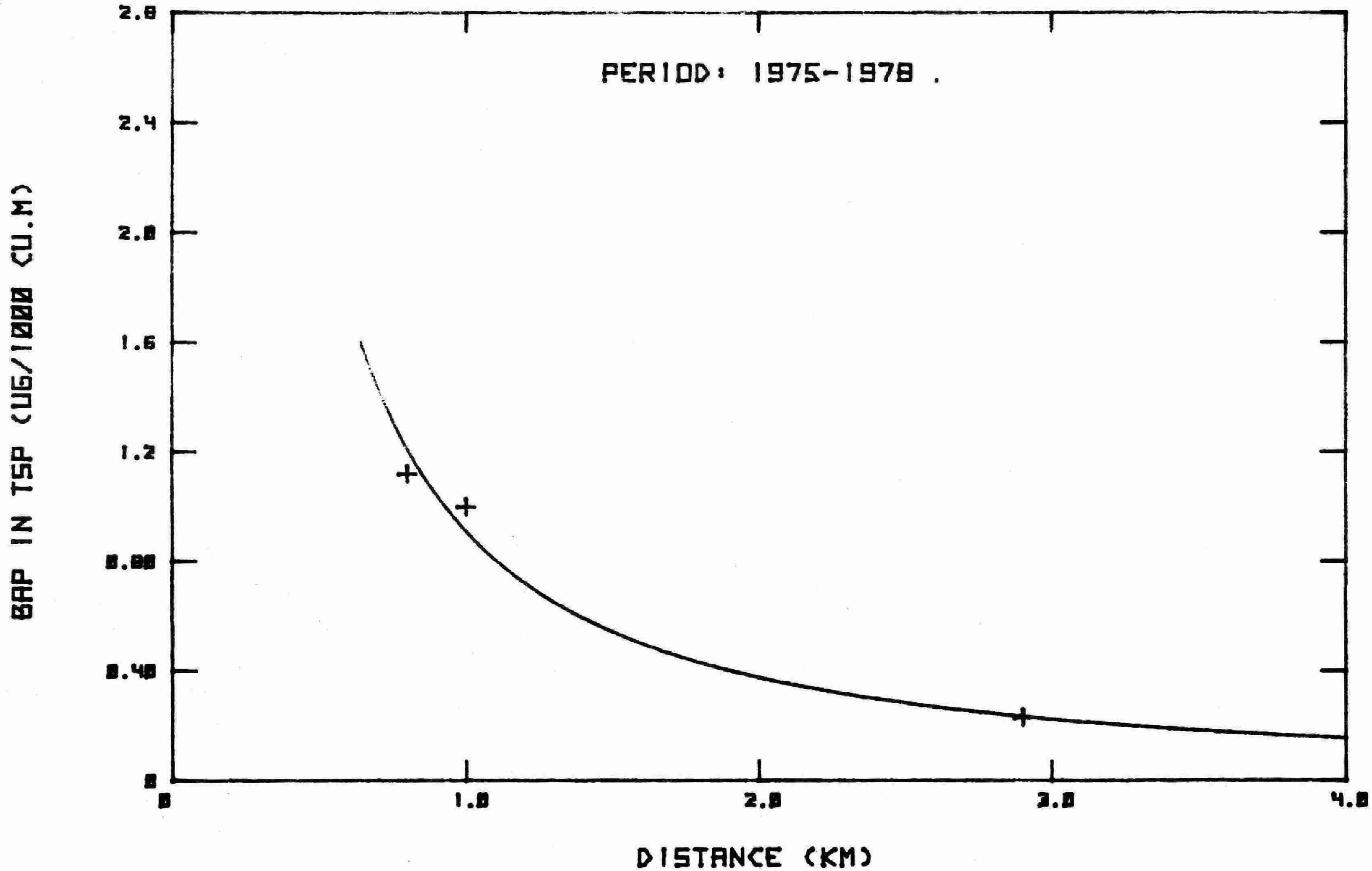


FIG. 42 BAP LEVELS VS DISTANCE FROM ALGOMA STEEL

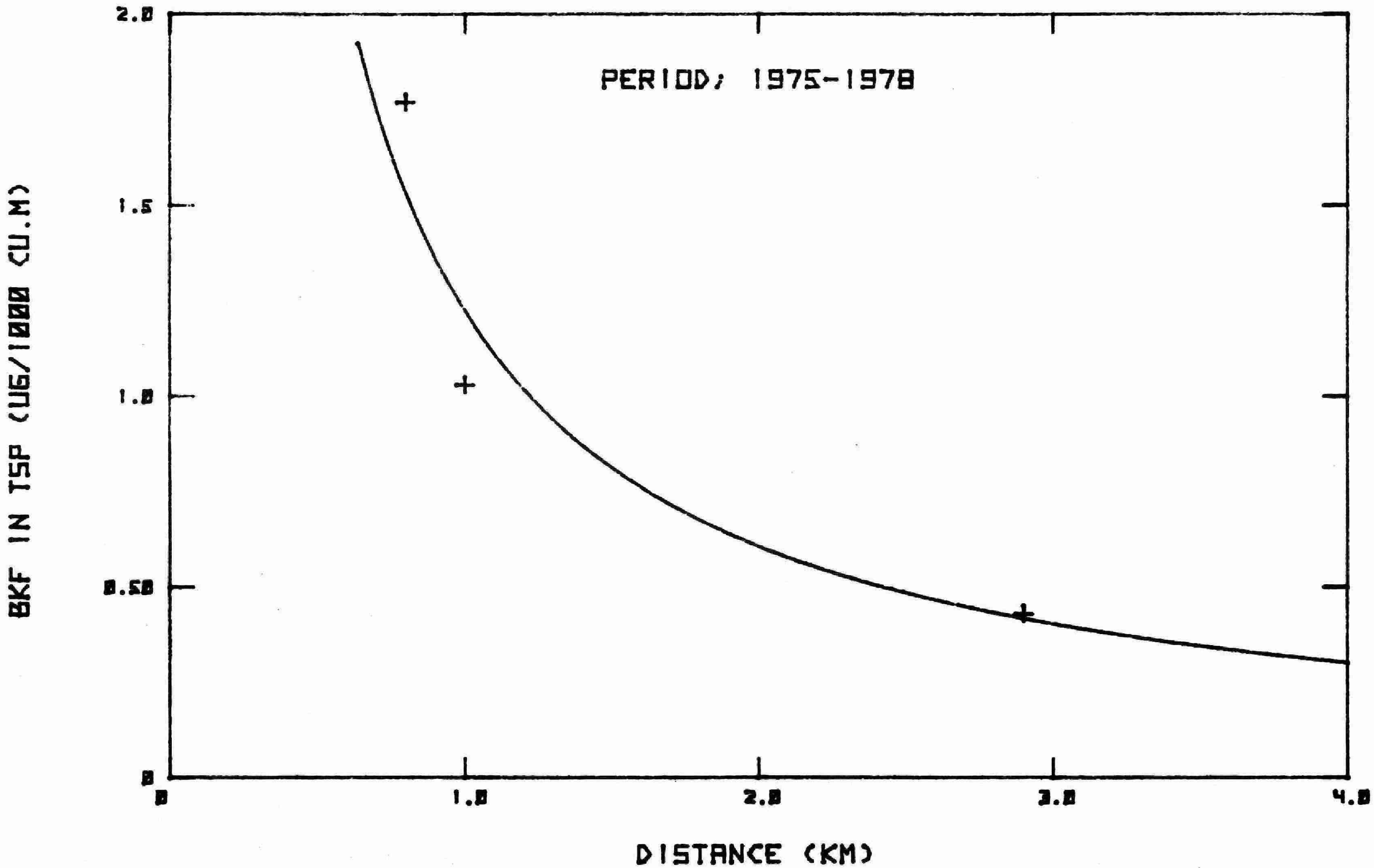


FIG. 43 BKF LEVELS VS DISTANCE FROM ALGOMA STEEL

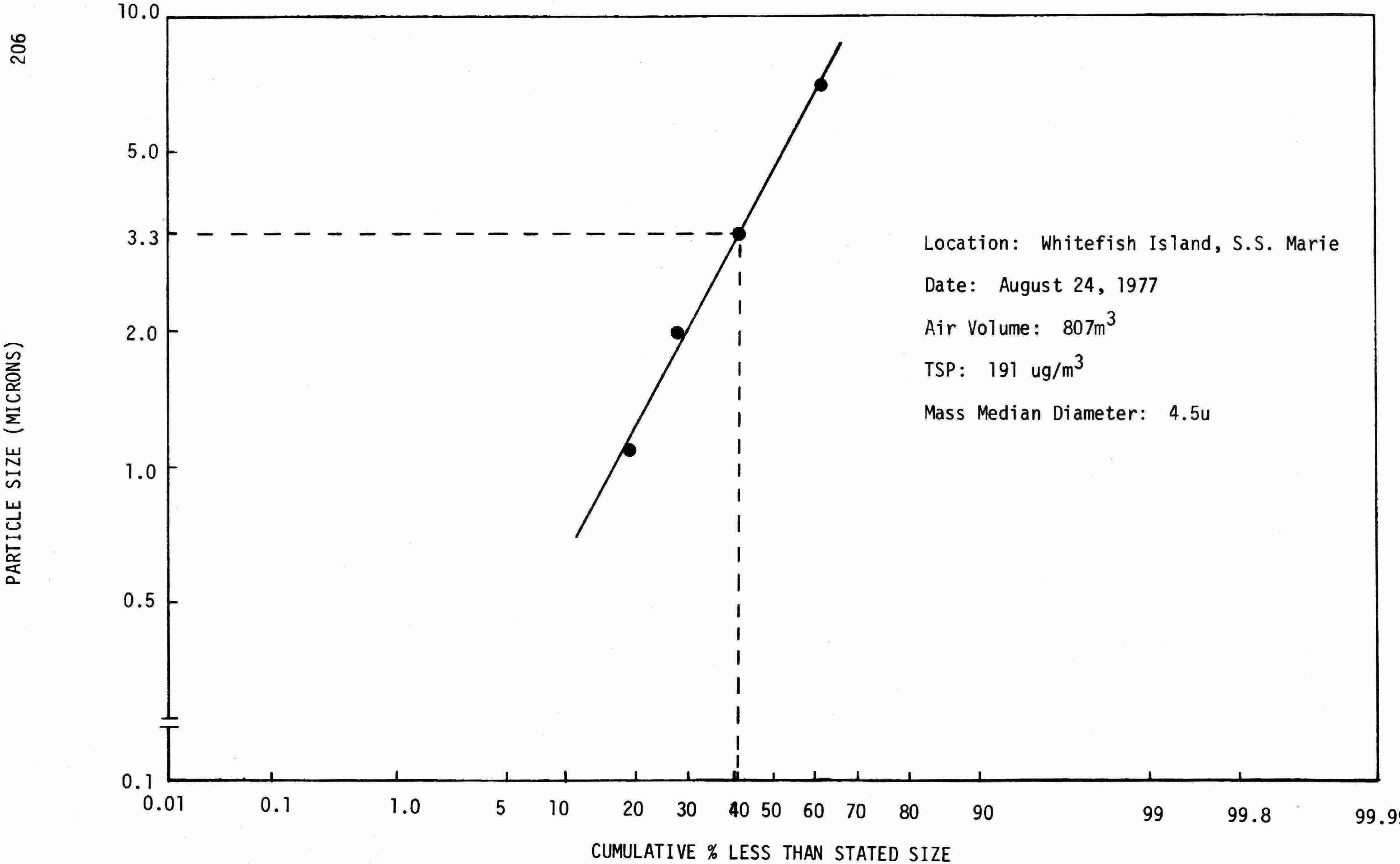


FIG. 44 TSP PARTICLE SIZE DISTRIBUTION

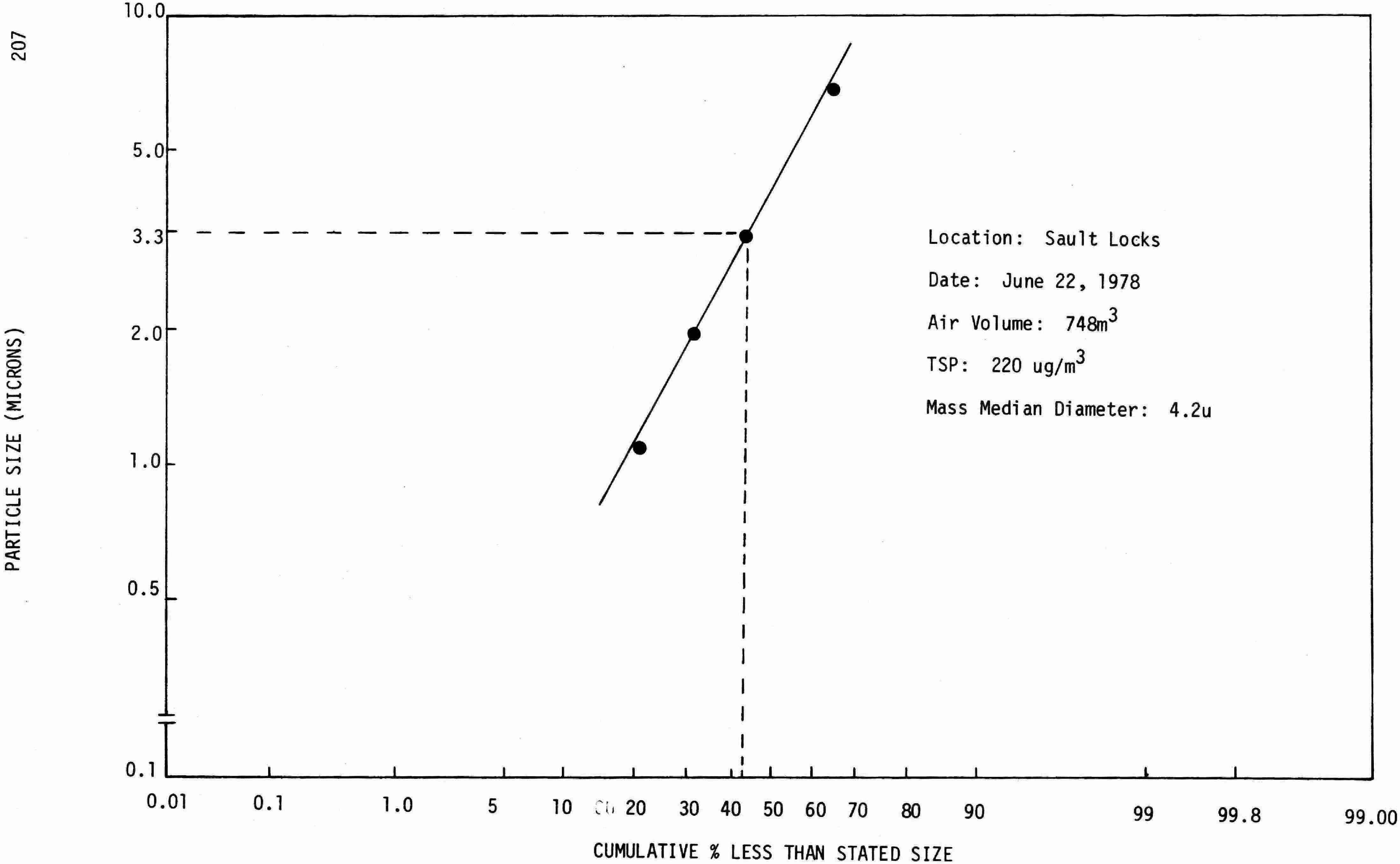


FIG. 45 TSP PARTICLE SIZE DISTRIBUTION

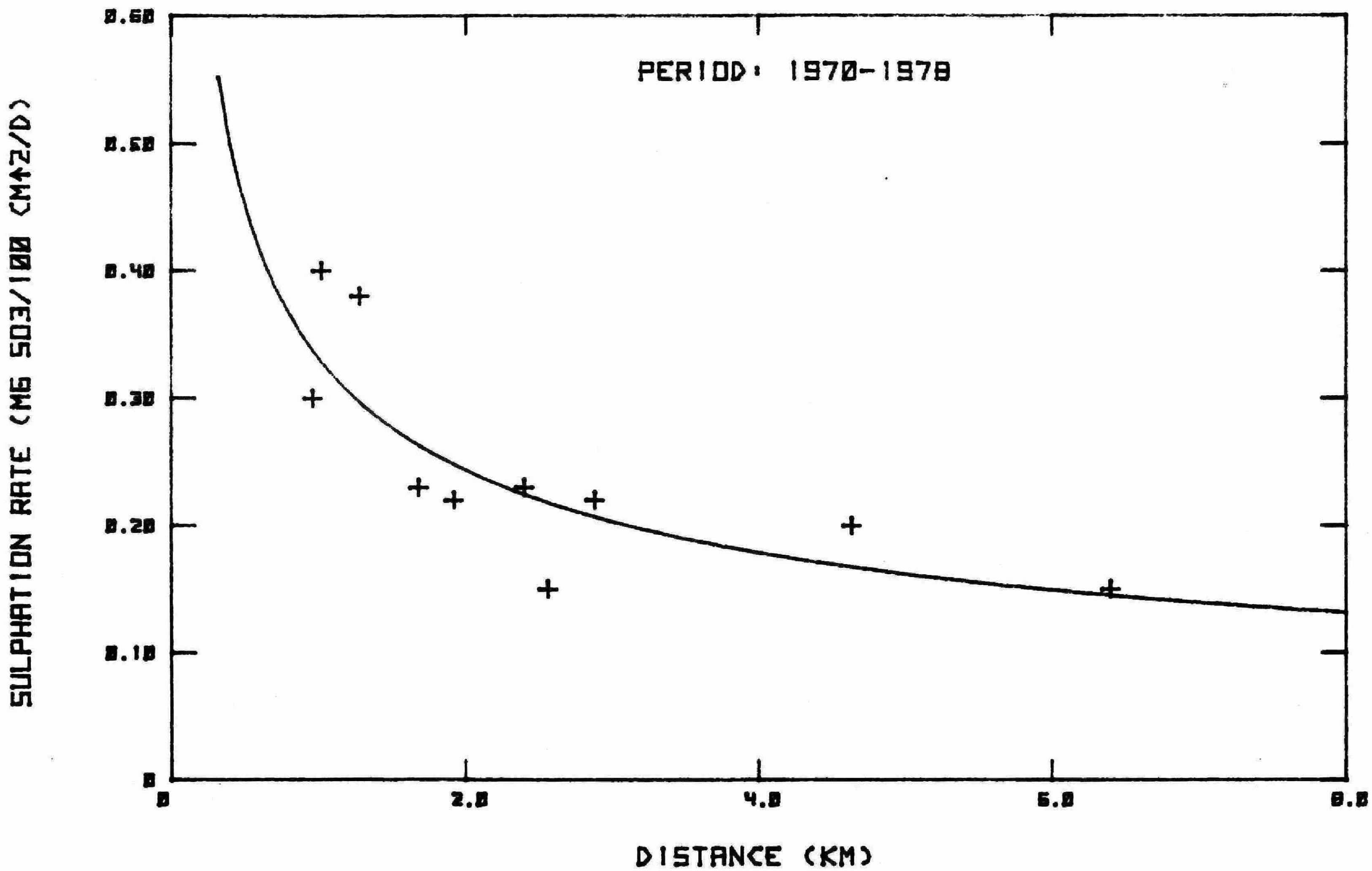


FIG. 46 SULPHATION RATE VS DISTANCE FROM ALGOMA STEEL

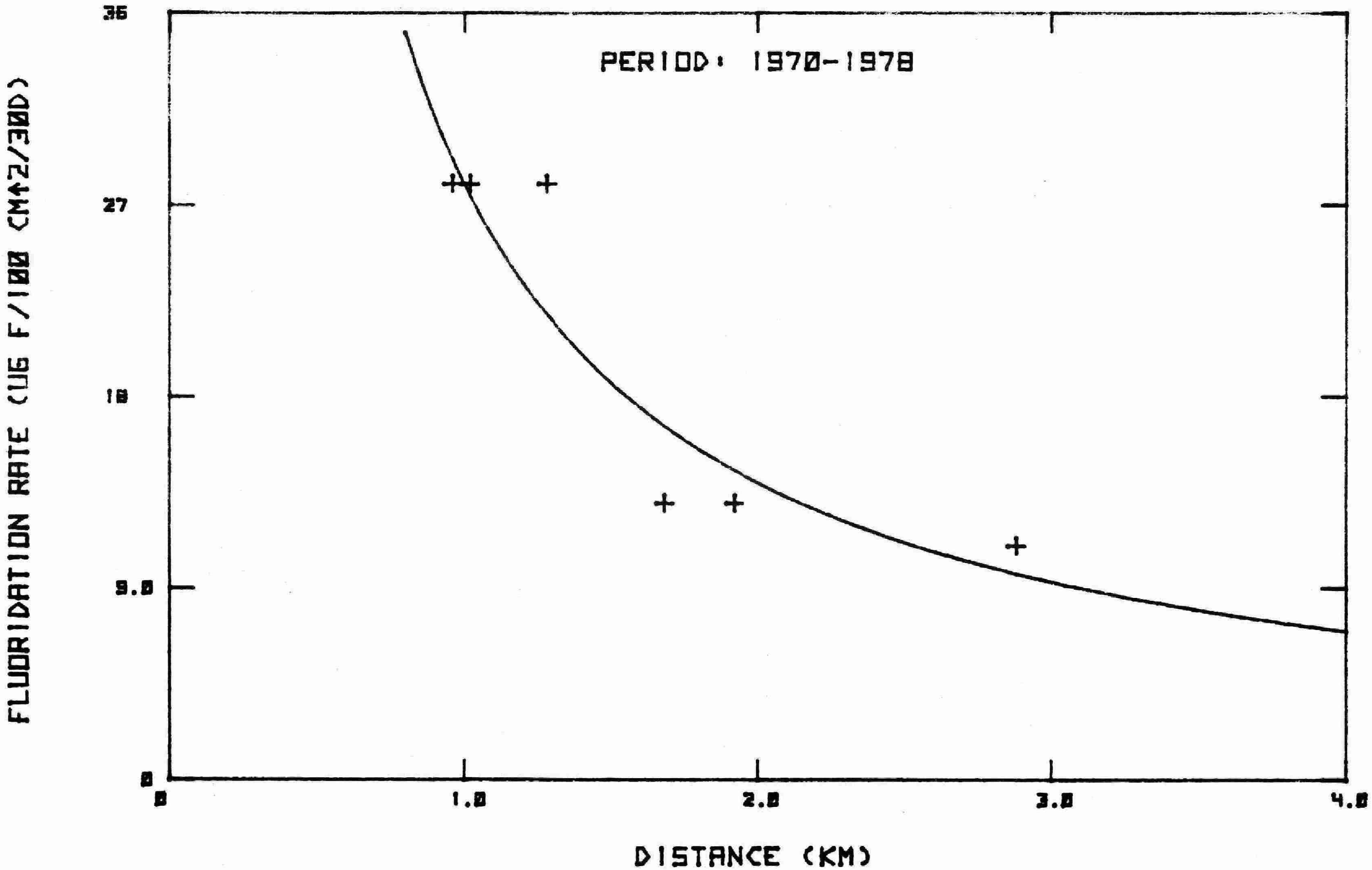


FIG. 47 FLUORIDATION VS DISTANCE FROM ALGOMA STEEL

Figure 48

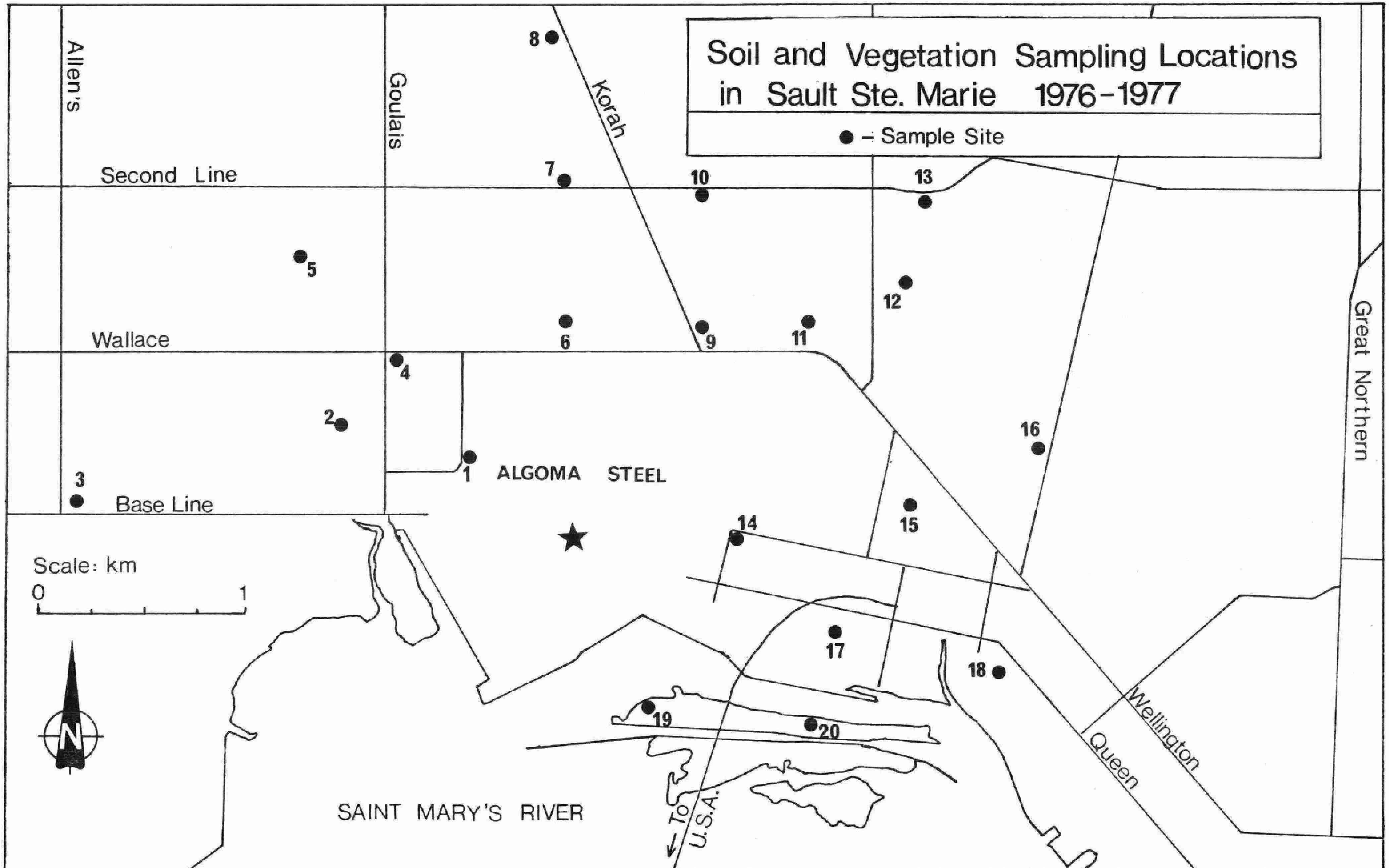
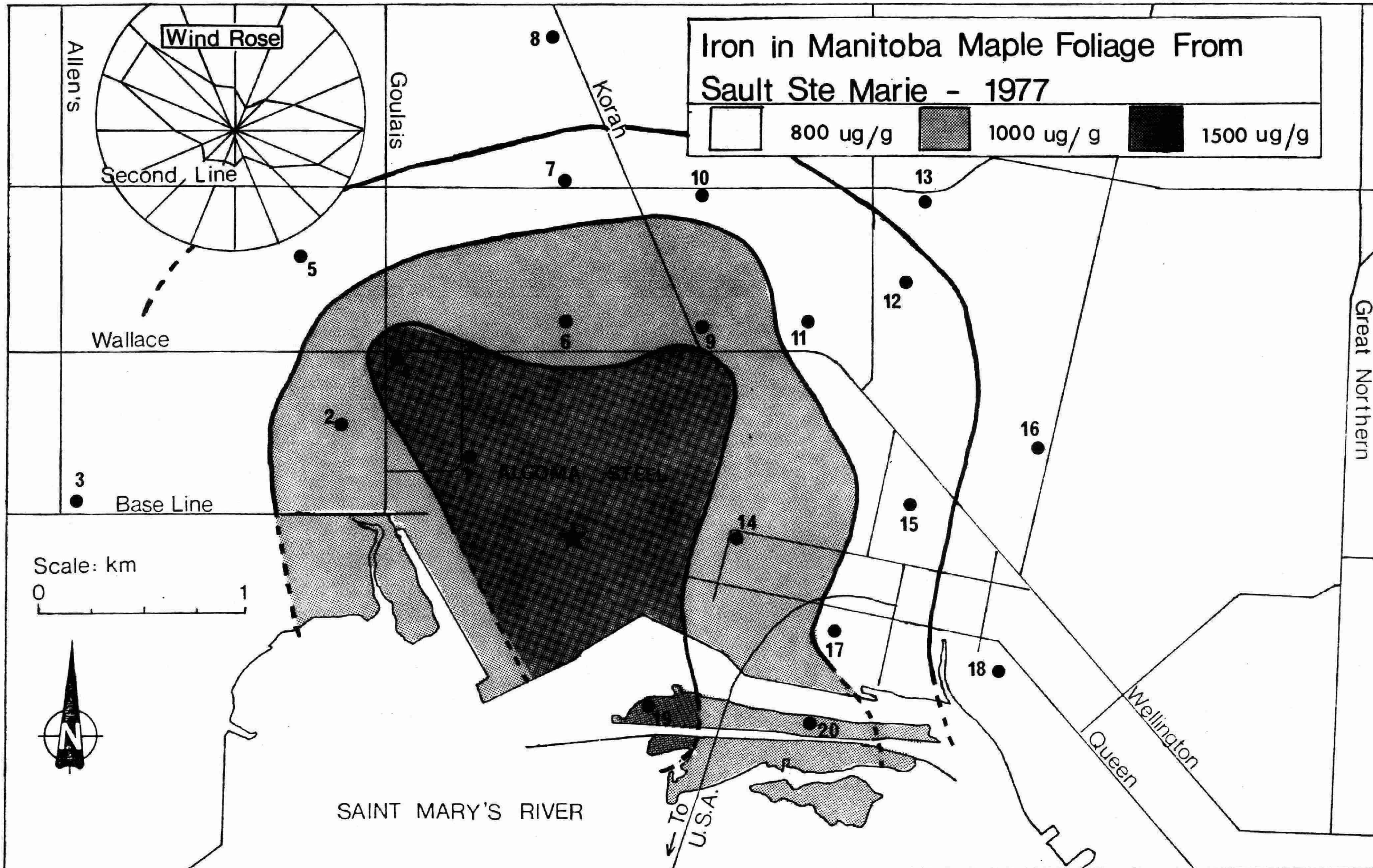

Soil and Vegetation Sampling Locations in Sault Ste. Marie 1976-1977
● - Sample Site
Allen's
Goulais
Korah
Second Line
Wallace
Base Line
Great Northern
Wellington
Queen
ALGOMA STEEL
SAINT MARY'S RIVER
To U.S.A.
Scale: km
0
1
N
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

Figure 49


Iron in Manitoba Maple Foliage From Sault Ste Marie - 1977
800 ug/g
1000 ug/g
1500 ug/g
Wind Rose
Allen's
Goulais
Korah
Second Line
Wallace
Base Line
ALGOMA STEEL
Great Northern
Wellington
Queen
SAINT MARY'S RIVER
To U.S.A.
Scale: km
0
1
N
1
2
3
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

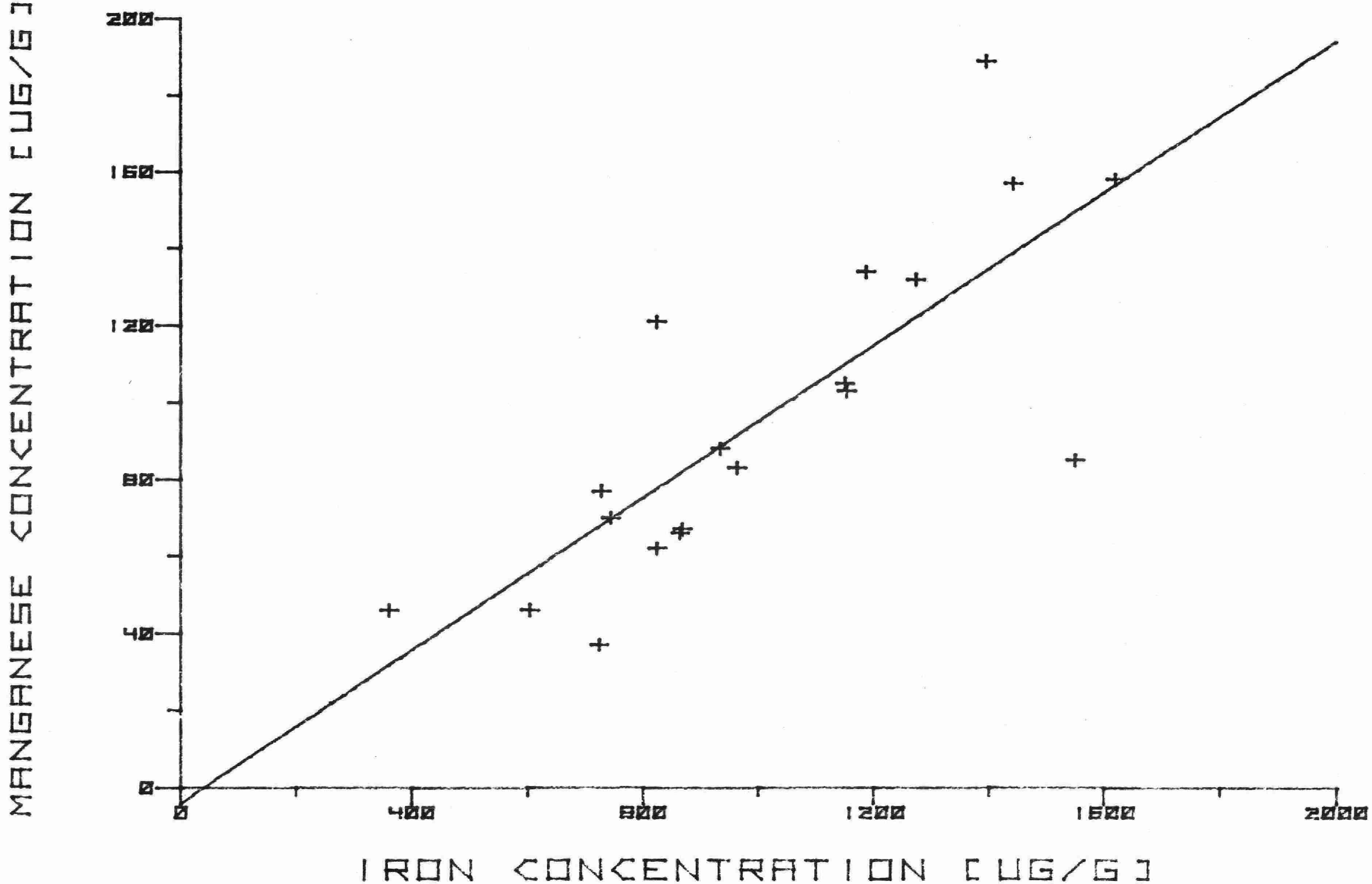
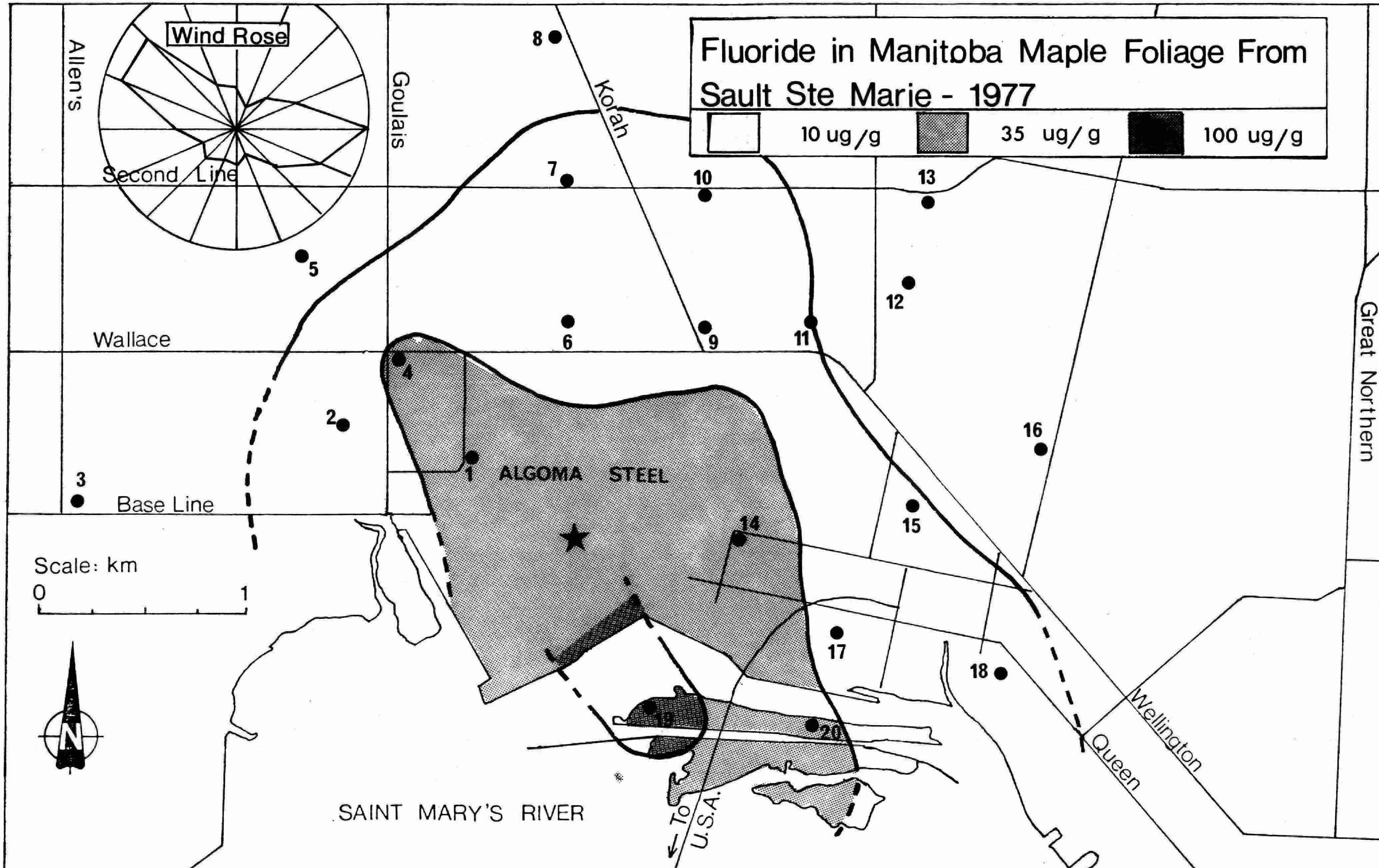

MANGANESE CONCENTRATION [UG/G]
200
160
120
80
40
0
0
400
800
1200
1600
2000
IRON CONCENTRATION [UG/G]

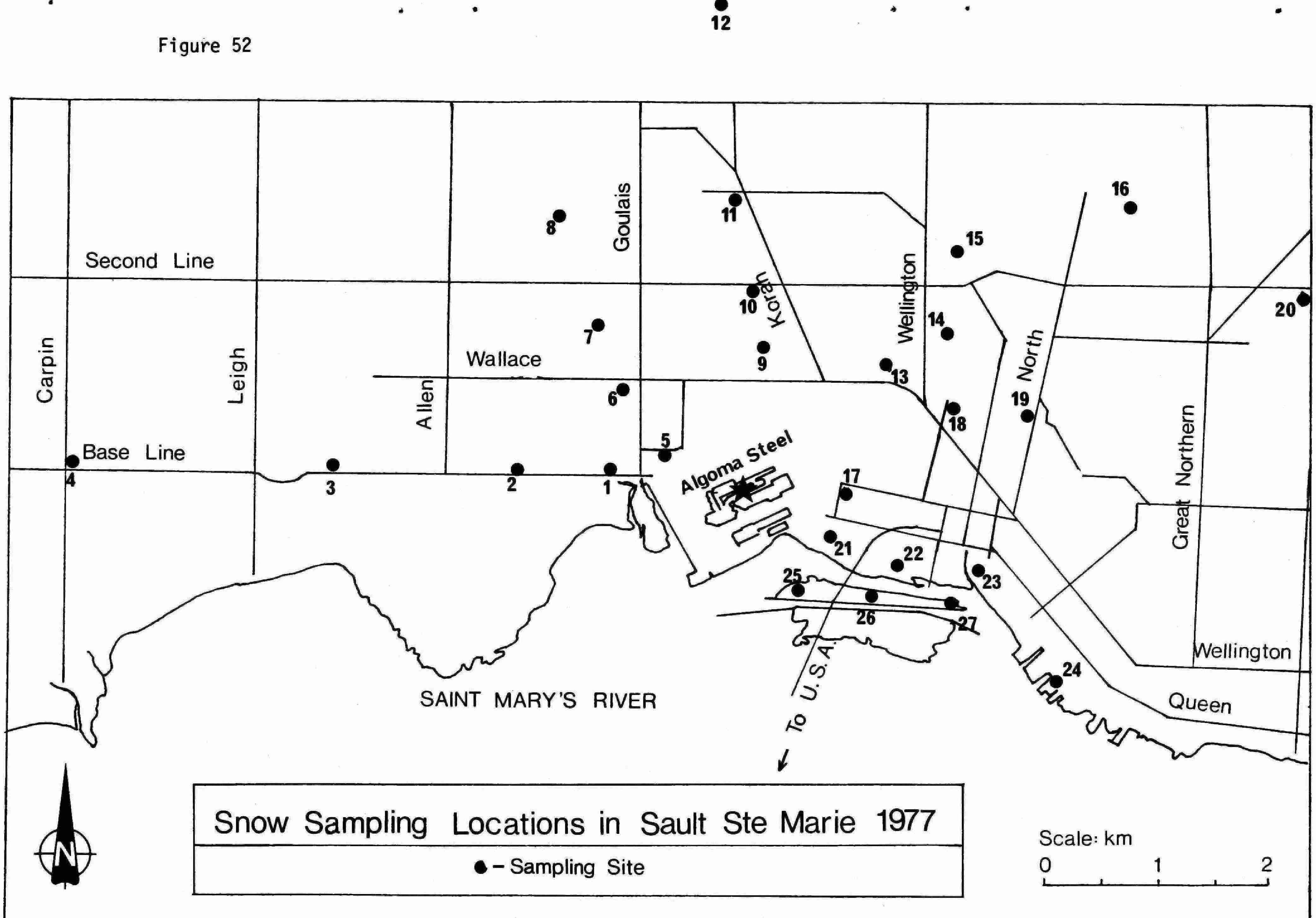
Figure 50

Figure 51



Fluoride in Manitoba Maple Foliage From Sault Ste Marie - 1977
10 ug/g
35 ug/g
100 ug/g
Wind Rose
Allen's
Goulais
Korah
Second Line
Wallace
Base Line
Great Northern
Wellington
Queen
ALGOMA STEEL
SAINT MARY'S RIVER
To U.S.A.
Scale: km
0
1
N
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

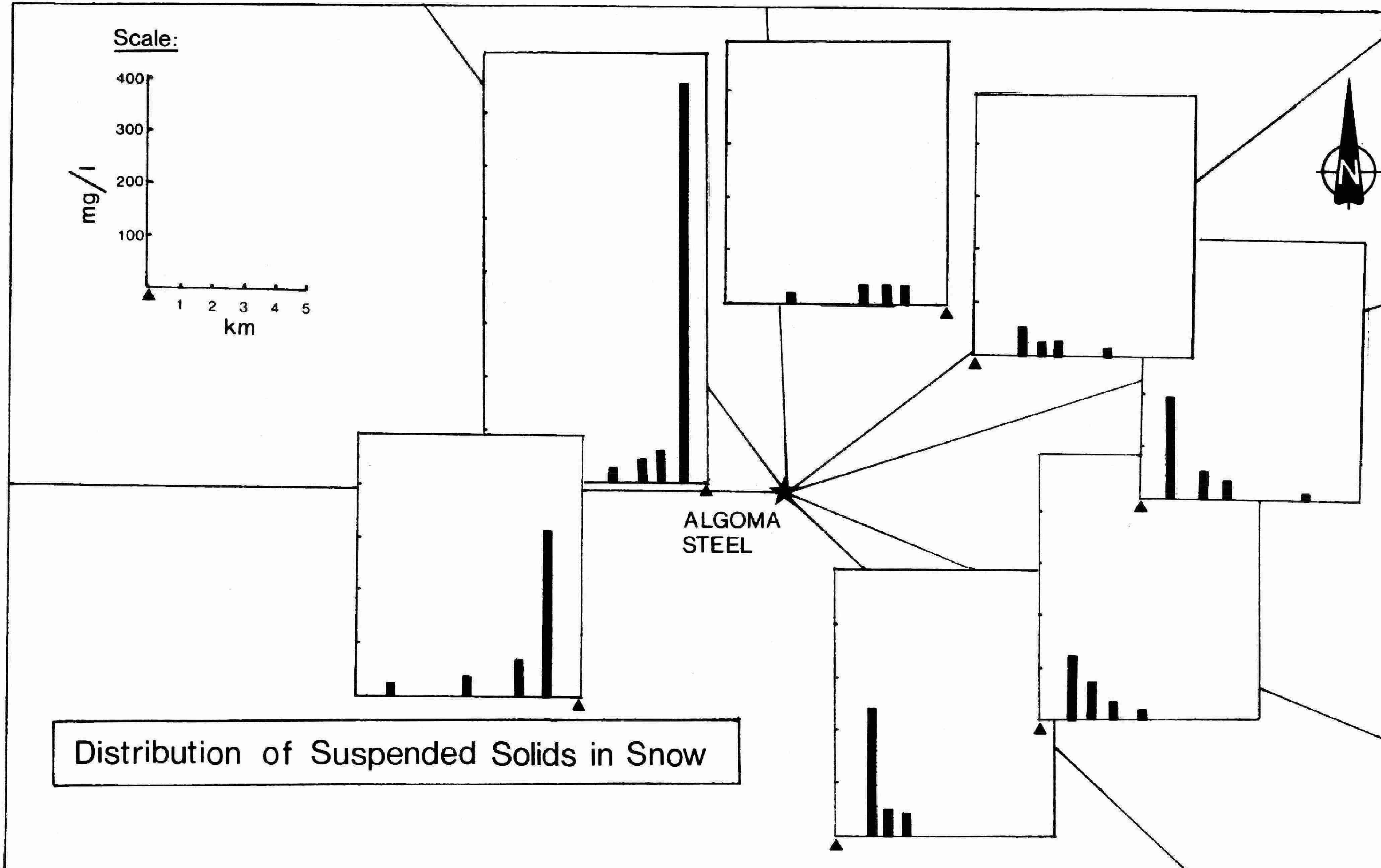
Figure 52



Snow Sampling Locations in Sault Ste Marie 1977

● – Sampling Site

Figure 53



Distribution of Suspended Solids in Snow

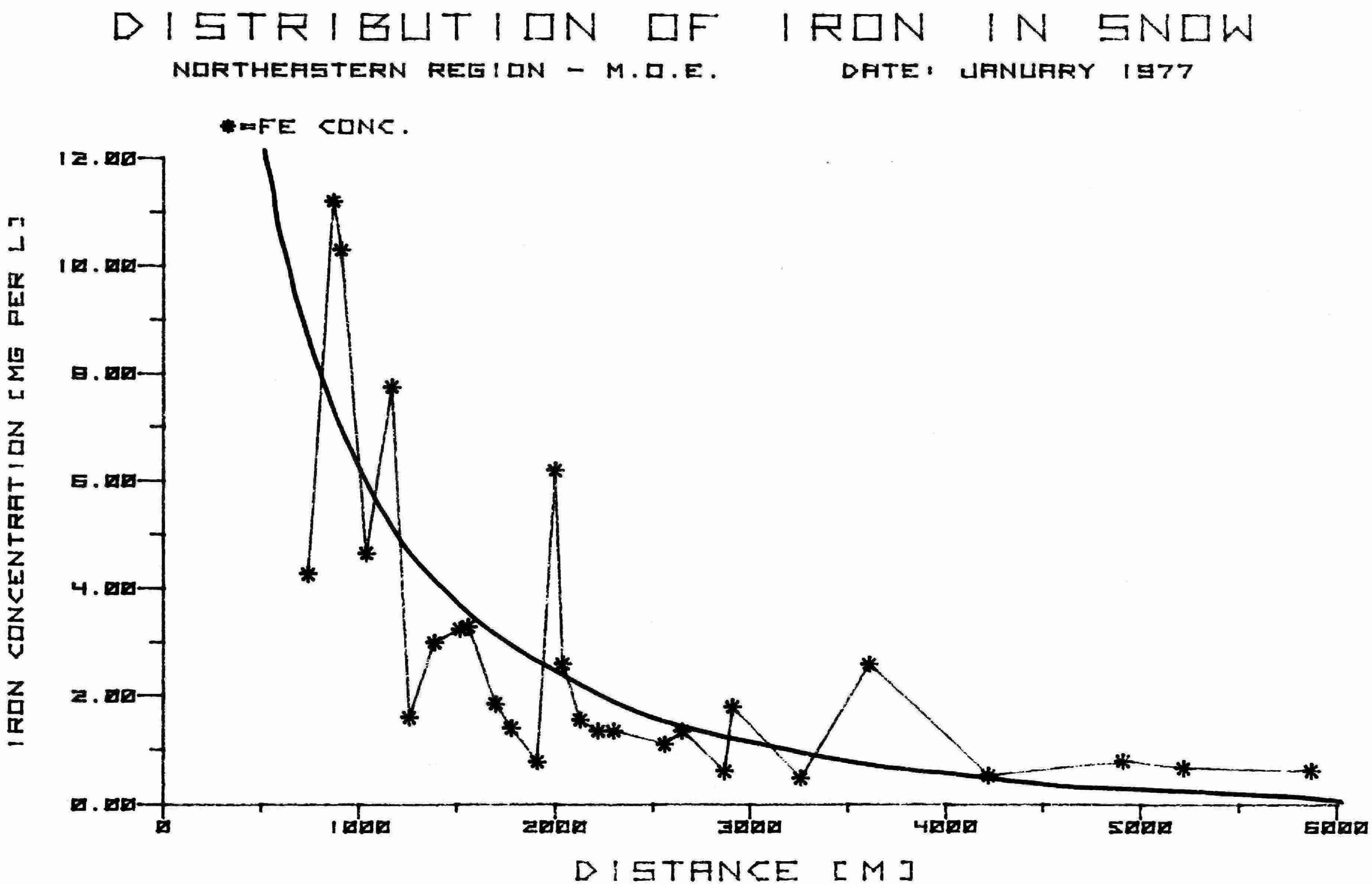

DISTRIBUTION OF IRON IN SNOW
NORTHEASTERN REGION - M.O.E.
DATE: JANUARY 1977
*=FE CONC.
IRON CONCENTRATION [MG PER L]
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0
1000
2000
3000
4000
5000
6000
DISTANCE [M]

Figure 54

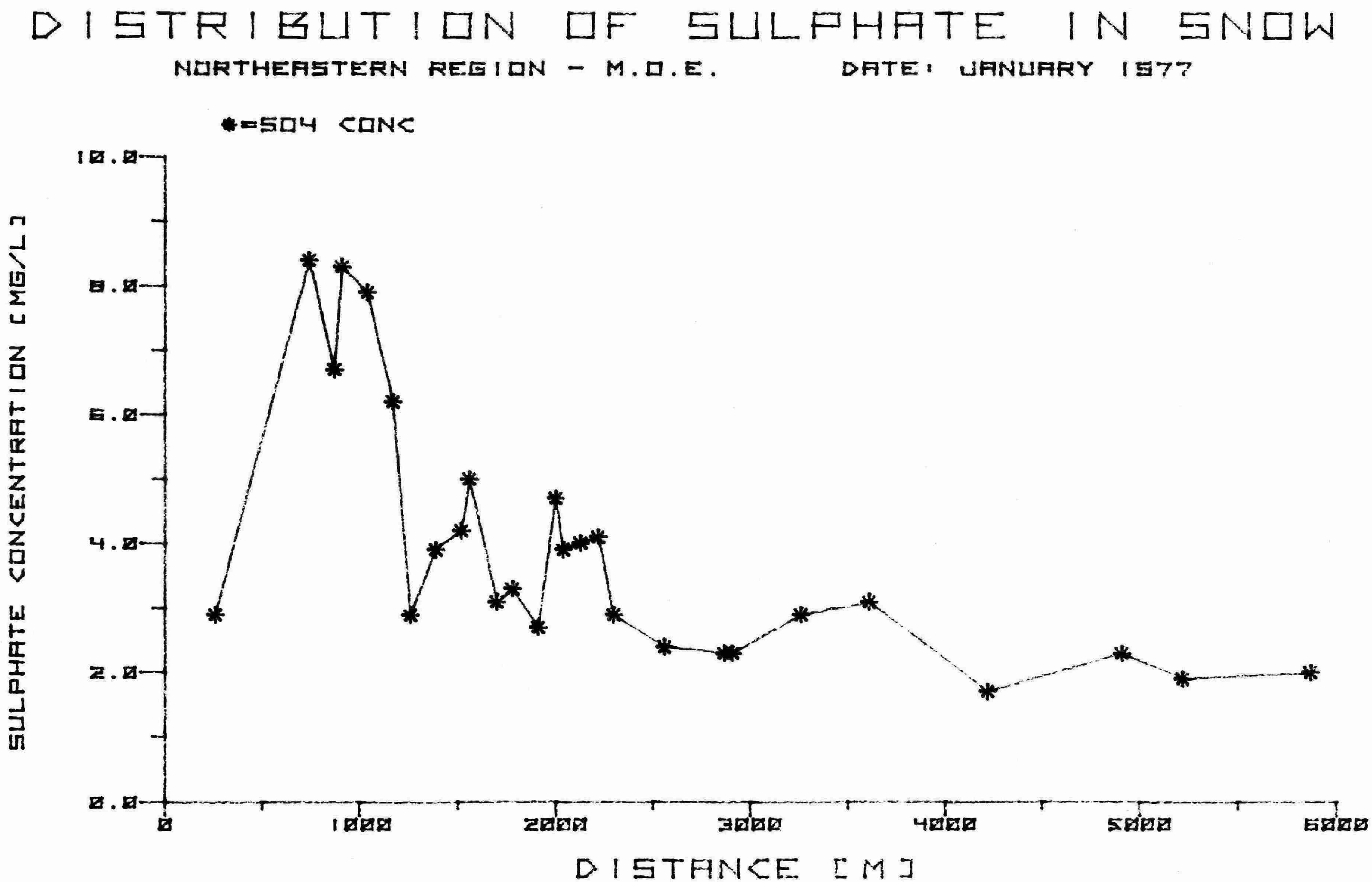

DISTRIBUTION OF SULPHATE IN SNOW
NORTHEASTERN REGION - M.O.E.
DATE: JANUARY 1977
*=SO4 CONC
SULPHATE CONCENTRATION (MG/L)
10.0
8.0
6.0
4.0
2.0
0.0
0
1000
2000
3000
4000
5000
6000
DISTANCE [M]

Figure 55

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